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# Zak Storey

# THE REVOLUTION HAS COME

**FOR THE LAST TWO ISSUES** I've started out my Editor's Intro by bringing up some bad news in one form or another. Whether that's page cuts, budget cuts, temporarily letting go of Jarred and Alex, or something else, it's been tough. I joined the team one week before our publishing house went into lockdown, and I've gotta say it's been a hell of a first experience. That said, this job is everything that I've wanted it to be, and the support I've received from all of you who've mailed in, and from those who I've spoken to personally on our Discord server (shameless plug: bit.ly/MPCDiscord) has been fantastic. We couldn't do what we do without you all, and I just want to thank you for that.

Nevertheless I'm happy to report that today I've got no bad news to share with you all. Everything at *Maximum PC* is running like clockwork right now; the team is doing well, producing some outstanding content on a very tight budget, and we've even started work on big plans for the coming year, requesting in hardware for massive build projects for the coming issues.

On top of that I actually have some good news for once. Next month we're getting a large chunk of our regular budget back, meaning you'll see a lot of the usual faces on our pages once again, and a step-up in our tutorials and features too (anyone curious about Wordpress?). I've also been informed that the 12 pages that we lost at the beginning of my tenure will return to *Maximum PC* once newsstands re-open across the U.S. And I've also managed to pester Jarred into writing a tech-talk for us this issue for free, as there's a ton to cover on Nvidia's new Ampere GPU architecture—yes, he is that much of a nice guy. So yeah, life's tough, but things are getting better, even in the precarious world of tech print journalism.

"All right, so what have we got in this issue Zak?" Good question! Well, we're taking a look at the home-working revolution! That's right. Many of us are now comfortably sat in our own home offices, wondering why on Earth we ever had to suffer through the morning commute to get to the bustling germ-filled world of our workplaces. And the answer is, you probably didn't need to. So, as working-from-home vets, we've divulged our top tips and tricks for setting up the perfect home office environment, from hardware to software and everything in-between. We'll make sure you're covered for this new world we're about to fall into.

We've also pieced together a fantastic 10-page feature on how to build your own $535 office PC. This kick-ass rig features a quad-core processor, 16GB of DDR4, and a 1TB PCIe SSD drive. It's affordable, powerful, and for the non-gamers out there, the perfect entry-level system or modern-day upgrade.

Combine all that with a Windows security lockdown, reviews on Intel's latest Cannon Lake processor, a plethora of tutorials, columns, and more, and I hope this is another kick-ass issue you'll all enjoy.

As always, stay safe out there, and I look forward to seeing you next time.

*Zak Storey is* Maximum PC's *editor and long-time staff member. He's been building PCs since he was 10, and is more than capable of butting heads with the biggest names in tech.*

↘ submit your questions to: comments@maximumpc.com

THE NEWS

# Nvidia Builds a Beast

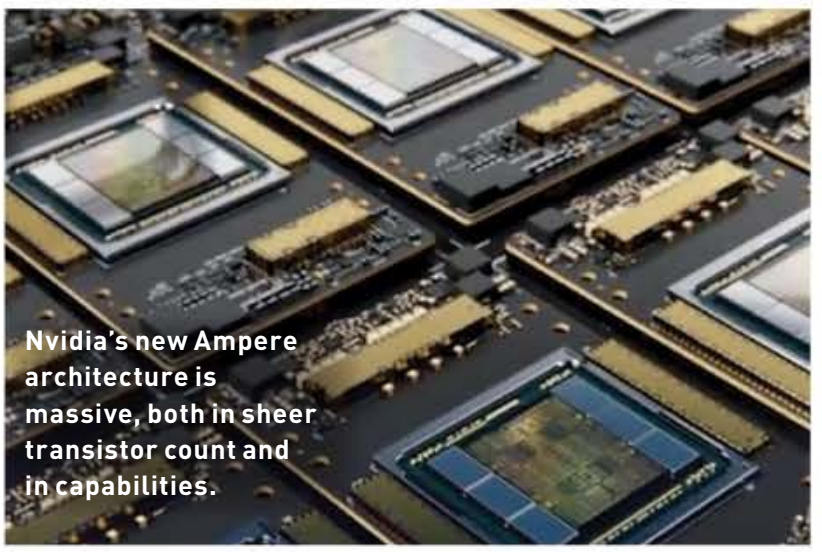
## Nvidia's 7nm monster GPU arrives

**NVIDIA HAS** a new GPU architecture called Ampere, and it is big. In fact the first Ampere chip is the world's biggest 7nm IC, with 54 billion transistors. It took, according to a "keynote" speech made by CEO Jensen Huang from his kitchen at home, the result of the efforts of thousands of engineers over several years. The first card to use the Ampere architecture will be the A100. This is aimed squarely at the data center where it will toil away at cloud services, data analysis, and artificial intelligence. This is the world of high-performance computing, and Nvidia's press materials are dotted with bar charts showing Ampere's capabilities above its previous card, the Tesla V100.

The A100 card will have, according to Mr. Huang, "a profound impact on how we architect data centers." For properly serious work, Nvidia has put together the A100 system board, which carries eight A100 cards, making the world's largest graphics card. Nvidia claims it has more transistors than have ever been put onto one computer. It's a beast.

All this is well and good, but what about gaming cards with this wonder chip? They are coming, but here we enter a murky world of leaks and unofficial information gleaned from anonymous sources, so a pinch of salt is required first. Nvidia is notoriously careful with its test cards, including anti-tamper devices and "black box" logging. What we've seen so far purports to be a GeForce RTX 3080 Ti, sporting triple fans and two eight-pin power connectors, indicating its increased power efficiency. Inside is a GA102 GPU with 84 streaming processors and 5,376 CUDA cores. There's expected to be GA103 and GA104 GPUs for GeForce 3000-series cards.

The card carries 12GB of memory with a bandwidth of 864Gb/s, 40 percent more than the RTX 2080. Exact frequency speeds are hard to calculate—the only software that can report it accurately is made by Nvidia—but the sample card apparently runs at over 2.2GHz on boost. The ray-tracing cores (missing on the A100) are much more efficient, by a factor of four. This should be the push ray-tracing gaming needs; currently you have to tread carefully with the options not to hit the refresh rates or playability too hard. DLSS, or deep learning super sampling–which has offered so much yet somehow never quite managed it—now reaches version 3.0, and while still not a magic performance bullet, it works a lot better. The result of all this is a card that is at worst 40 percent faster than a RTX 2080 Ti, and on some titles 70 percent.



Nvidia's new Ampere architecture is massive, both in sheer transistor count and in capabilities.

Even though all this is unconfirmed rumor, it is hard not to be excited. Ampere is going to be the card that can give 4K gaming the power it needs. When? If previous launches are anything to go by, Ampere will appear first on Tesla cards, then Quadro. These should appear by the fall. GeForce could possibly be in time for the holidays.

Meanwhile Intel is about to throw its hat into the graphics card ring. It has poured not inconsiderable resources into its own graphics engine, called Xe, and we aren't too far away from seeing the first fruits, first in Tiger Lake mobile chips, but what is more interesting is its fully discreet graphics card. Intel is starting to tease with pictures and hints of "tens of billions" of transistors. It's a big jump from capable but unprepossessing integrated graphics to building a full-blown gaming card, but Intel's engineers seem confident.

Elsewhere, AMD is working on its next-generation GPU, currently known by many names: Big Navi, or Navi 2X, or RDNA 2, etc. It's expected to bring a gain of about 50 percent per watt and employ up to 5,120 cores. The competition is fierce, and is only getting fiercer; before the end of this year we'll have new benchmark records, and epic battles for the best graphics card in each sector. **–CL**

> If previous launches are anything to go by, Ampere will appear first on Tesla cards.

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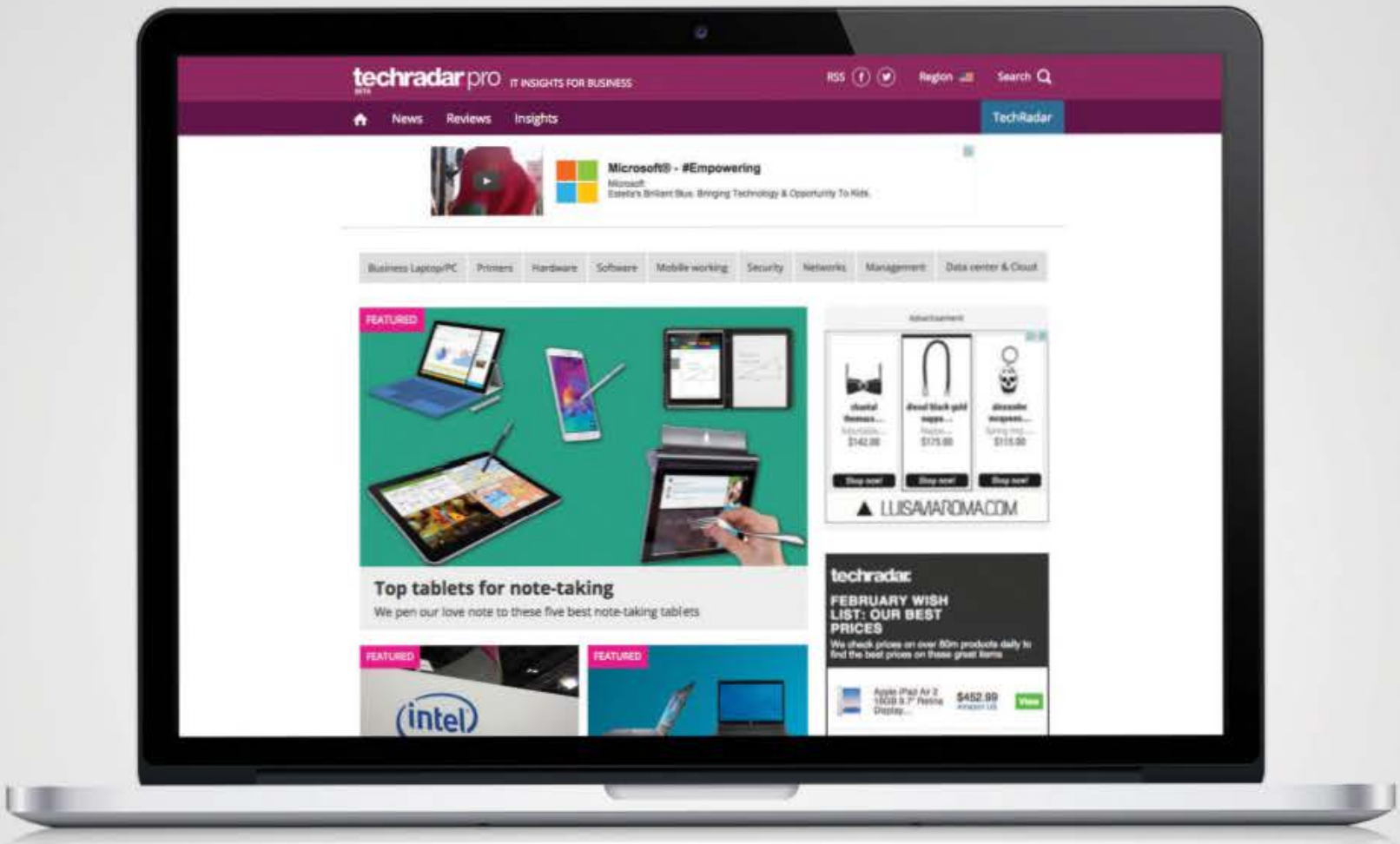


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# MICROSOFT WAS WRONG ABOUT OPEN SOURCE

## PRESIDENT SAYS THEY'RE FREINDS

**IN 2001 THE THEN-CEO** of Microsoft, Steve Ballmer, called Linux "a cancer that attaches itself to an intellectual property sense to everything it touches." The company has calmed down since then. The current president, Brad Smith, thinks that "Microsoft was on the wrong side of history when open source exploded."

Not only has Microsoft stopped fighting open source, it has joined in. A Linux kernel is now part of Windows 10, enabling it to run Linux software directly, and the company is now the world's largest single contributor to open-source projects.

Microsoft's new "open design philosophy" means we are likely to see more open-source projects folded into Windows, and a bit more of Windows opened up to the world. **–CL**

# AMD OFFERS A REPRIEVE FOR 400-SERIES BOARDS

## Last-minute patch saves your motherboard

**WHEN RYZEN**, and its AM4 socket, was launched in 2016, AMD said it would support the socket until 2020. Which it has, although some interpreted this as meaning the motherboard chipsets would also support all AM4 chips. When the Zen 3 came along AMD said you needed a 500-series board. Its new B550 has just arrived, and it doesn't support Ryzen 3000-series Picasso chips with integrated graphics, or support older Ryzen 2000 or 1000-series chips.

The company has now decided to change course. The issue was room on the ROM. AMD is preparing a BIOS update that will enable Zen 3 support on B450 and X470 boards. This works by making room on the ROM by ditching support for older Ryzens. It's a one-way process that kills the board for older silicon, so it will only be available to verified 400-series owners who buy a Zen 3 chip. It's not quite the level of support we might like, but it's better than none. **–CL**

# Tech Triumphs and Tragedies

**A monthly snapshot of what's good and bad in tech**

## TRIUMPHS

**VIDEO GAMES RECORD**
We spent more in the last quarter on games then we ever have—a whopping $10.9 billion, up nine percent on last year.

**FOUNDRY FOR ARIZONA**
TSMC is to build a cutting-edge semi-conductor foundry in Arizona to produce 5nm parts. It'll be ready by 2024.

**MICROPROSE ISN'T DEAD**
Classic game-maker MicroProse is being resurrected, with new games and refreshed work.

## TRAGEDIES

**WINK OUT**
With little notice, Wink has moved to a $5 a month subscription—if you don't pay, your smart home hubs stop.

**ZOOM**
It seems that Zoom's claim of having 300 million daily active users wasn't true: It counted every participant in every call.

**WALMART CLOSES JET**
The online shopping site that cost Walmart $3 billion in 2016 is set to close.

# TIGER LAKE HAS CLAWS

## Intel's new mobile chip promises double-digit speed bump

**INTEL'S 11TH-GENERATION** Tiger Lake is set to launch, and the company claims there are 50 "fantastic" notebooks ready to roll. Tiger Lake is the replacement for the Ice Lake series of low-power mobile processors with integrated graphics. It uses a 10nm processor and sports Intel's most modern core architecture, Willow Cove, an enhanced version of Ice Lake's Sunny Cove.

The specifications read well: We have PCIe 4.0, Wi-Fi 6, USB 4, Thunderbolt 4, deep-learning AI boost, HEVC, and VP9 hardware decoding. The two things that stand out are the graphics sub-system: This will be the first commercial appearance of Intel's Xe graphics engine, with up to 96 execution units, against 64 in Ice Lake. The other is that Intel has managed to crank up the clock speeds while keeping power consumption down. A four-core engineering sample much reported (probably a Core i7-1165G) has a TDP of 25W but manages a base clock speed of 2.8GHz. This is better than the Ice Lake i7-1068G, which chugs along at 2.3GHz while burning through 28W. There will be faster varieties too—a 3GHz chip has been spotted. Add a few IPC gains, and we have a decent jump in processing power. The Xe graphics will build on that, bringing a "huge leap" according to Intel. The upshot is a double-digit performance boost over its predecessor.

Tiger Lake will be competing head to head against AMD's 7nm Ryzen 4000-series mobile parts, which have earned praise for their performance. Intel has responded robustly, and AMD has a fight on its hands in the lucrative mobile market. All this is excellent news if you are in the market for a new notebook. Meanwhile, we are still waiting for Intel to get its latest designs into the desktop. **–CL**

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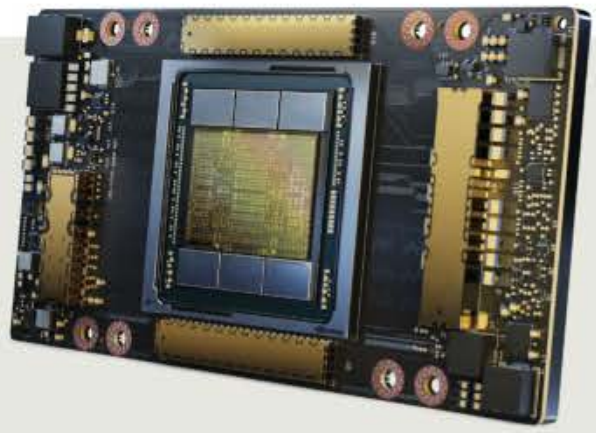
Jarred Walton

TECH TALK



# The Nvidia A100 is the Largest GPU Ever Created

**THE GPU WARS ARE HEATING UP.** Nvidia finally took the wraps off its Ampere architecture and the GA100 GPU that will reign as the company's new king. Or maybe emperor, because this is one monster of a chip. This is the next iteration of Nvidia's datacenter and supercomputer ambitions, so it's not going into a gaming graphics card. But damn if the chip still isn't exciting!

Let's start with the raw specs. The full GA100 chip has 128 SMs (streaming multiprocessor), which are the main building block of Nvidia GPUs. The previous-generation Volta GV100 for comparison maxed out at 84 SMs (with 80 enabled), so right away we're looking at more than a 50 percent increase in potential performance, though the initial Nvidia A100 will "only" have 108 SMs enabled. Like Volta (and Pascal GP100), each SM has 64 FP32 CUDA cores, plus 32 FP64 CUDA cores. Where it gets interesting is in the other cores.

Like Volta—and unlike Turing—there are no RT cores for ray tracing. That obviously puts the kibosh on these becoming gaming chips, if the size and transistor count didn't already clue you in. More importantly, however, the Tensor cores are getting a major upgrade. The new A100 only has half as many Tensor cores per SM—four instead of eight—but those four cores provide twice the performance of the previous-generation Tensor cores.

These 3rd-generation Tensor cores have a few new tricks, specifically FP64 support (for science!), sparsity acceleration for matrices that aren't fully populated, and a new TF32 format that has the range of FP32 with the precision of FP16. It's basically like Google's bfloat16 format, using 19 bits with 10 for the exponent, eight for the mantissa, and one bit for the sign. What that means is a massive jump in deep learning and number-crunching calculations.

> Right away we're looking at more than a 50 percent increase in potential performance

The Tesla V100 had peak throughput of 125 TFLOPS for FP16 deep-learning operations, but 7.8 TFLOPS for FP64 calculations. The Nvidia A100 has peak throughput of 312 TFLOPS for FP16, and up to 624 TFLOPS for FP16 operations with sparse matrices. It also has half that level of performance with TF32 operations and can do 19.5 TFLOPS of FP64 on the Tensor cores. That's 2.5 times faster for FP64, and Nvidia says in FP32 workloads (using TF32) the A100 is up to 20 times faster than the V100.

What about "normal" graphics workloads, using the CUDA cores? There are 6,912 FP32 CUDA cores on the A100, so 35 percent more potential performance, though boost clocks are slightly lower: 1410MHz vs. 1530MHz. That's still at least 24 percent more theoretical performance, and updates will likely make it much more.

For memory, the full GA100 chip has six 8GB HBM2 stacks running at 1,215MHz (up from 877.5MHz on V100), but the A100 accelerator only has five stacks enabled. That still means 40GB of memory on a 5120-bit bus and 1.6 TB/s of bandwidth, and potentially more on a future product. Power could be the limiting factor, as even the A100 with only 85 percent of the SMs enabled still has a rated TDP of 400W.

***Above:*** **The GA100 packs 54 billion transistors into an 826 mm² chip.**

The A100 supports a new feature called multi-instance GPU (MIG) that allows a single A100 chip to be partitioned into as many as seven "separate" GPUs, each delivering the equivalent instancing power of a single Tesla V100. Through MIG, Nvidia intends to serve the scale-out (more instances) as well as scale-up (more aggregate performance) markets. MIG will be beneficial for inferencing workloads, running previously trained deep-learning networks, while the full A100 can be put to use training such workloads.

Want even more performance? Stuff eight Nvidia A100 GPUs into a DGX A100 server, and you've got 156 TFLOPS of peak FP64 performance, up to 2.5 PFLOPS of TF32 performance, and 5 PFLOPS of FP16 performance. All for just $199,000! Or a DGX A100 Superpod can house 140 DGX A100 systems with 700 PFLOPS of FP16 throughput. Needless to say, supercomputers intend to make good use of the A100, with plans for Exascale (ExaFLOPS) supercomputers well under way.

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

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# THE LIST

## THE BEST MICROPHONES FOR HOME USE

### 8 BLUE YETI NANO

A more compact model of Blue's classic Yeti mic, this is a great starter microphone for anyone who is looking to break into streaming or podcasting.

### 4 RAZER SEIREN ELITE

The best free-standing mic from Razer. It's not cheap, but the Seiren Elite packs effective audio sensitivity and a high-pass filter into its single-capsule casing.

### 7 SAMSON METEORITE

A shiny spherical mic with a magnetic base, the Meteorite is feature-light but not too expensive, and the recording quality is excellent.

### 3 AUDIO-TECHNICA AT2020USB+

A professional mic from a respectable brand, the AT2020USB+ is perfect for solo podcasting or live streaming. The tripod is a bit unstable, though.

### 6 RØDE NT-USB

A pop shield and tripod make this a professional-looking microphone that apes studio-level hardware without breaking the bank.

### 2 BLUE YETI X

Blue's best microphone, it's equipped with the excellent Blue Vo!ce software for the best in flexibility and customization. A noise-reduction toggle is invaluable.

### 5 BEYERDYNAMIC FOX

A rare combination of USB-A connectivity and hi-res 96 KHz/24-bit audio support, the FOX is a multipurpose beauty, equally at home recording music and speech.

### 1 HYPERX QUADCAST

Simply put, this is the best USB microphone available right now, boasting high build quality combined with fantastic audio pickup and intuitive physical controls.

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HEAD TO

BY **CHRISTIAN GUYTON**

# Headsets vs Speakers vs Headphones

What's the best audio solution for PC users? Audiophile headphones are designed with music in mind, aiming to deliver the ultimate audio quality for professional and enthusiast users, while speakers—that's proper 2.1 speakers, not the tinny ones built into your monitor—are more about loud, room-filling sound. Then there's gaming headsets, brimming with cool features and designs to benefit PC gamers. All are good, but which option is best?

## ROUND 1

### Value

This is a tricky one, since there's a broad price range for all three options. The more you spend, the better quality you get—mostly, anyway. So we're going to consider price against purpose, and price against performance. Gaming headsets take an early lead here, as they almost always include a built-in or detachable mic, and can be used for work, music, or gaming.

Audiophile headphones and speakers are typically more limited, and have a significantly higher ceiling for the amount of money you can spend. A high-end pair of Sennheiser headphones will run in excess of $1,000, while Razer's most expensive headset, the Nari Ultimate, is half that.

Speakers aren't too bad, with Razer's own high-end 2.1 sound solution (the Nommo Pro) costing around $500. The lower end of the price spectrum is kinder to audiophiles, with both headphones and headsets offering budget-friendly options, but if you actually work with music professionally, you may find that cheaper headphones just don't cut it.

With gaming, pitch-perfect audio clarity isn't quite as important compared to elements like mic quality and surround sound, so a less expensive headset will often suffice.

**Winner: Headsets**

## ROUND 2

### Performance

Again, money talks here, but we think there's a clear winner—or at least, a clear loser. In terms of pure audio quality, gaming headsets just can't measure up against either audiophile headphones or 2.1 speakers. Yes, some audio will sound better on a headset—the punchy impact of a grenade detonating in a game might carry more weight—but broadly, gaming headsets aren't required to have the absolute best-quality drivers and materials.

To a certain extent, nor are speakers, but a 2.1 speaker setup has the advantage of size, with a separate subwoofer that allows for richer, more intense bass notes. In terms of raw volume, it's easy for 2.1 speakers to blast out audio, although many users will argue that surround sound is best experienced with headphones.

Musical professionals demand a higher quality of sound; the average musician is more likely to appreciate subtle changes in audio than the average gamer. In order to appeal to audiophiles, headphones need to offer the best sound possible. Brands such as Grado, Denon, and Sennheiser know this: other features are always secondary to the sound, and optimizing audio quality is the way to go.

**Winner: Headphones**

## ROUND 3

### Versatility

We're starting to feel sorry for speakers now. They serve a purpose, but versatile they ain't. Headsets and headphones can be carried around either on your head or in a bag; many come with a carry case and compact, foldable design. Tape a 2.1 subwoofer to your head and you'll get some weird looks on the subway.

So, with speakers out of the running, we decided to look at connection standards; audiophile headphones are rarely wireless, and often use the chunkier 6.3mm audio jack as opposed to the more common 3.5mm connector. This necessitates the use of an adapter for many devices, including computers, phones, and consoles. There's no significant boost to sound quality from either connector, but using an adapter is likely to impact performance by a small amount, which isn't ideal.

Gaming headsets are more likely to be wireless (either using Bluetooth or via a USB dongle), so nothing gets in the way of the audio experience. Wireless connections—perhaps with the exception of 2.4GHz connections—tend to cause a small drop in sound quality. This isn't a concern for most gamers but will be for musicians, hence the scarcity of wireless headphones from key manufacturers. Overall, headsets win.

**Winner: Headsets**

Master & Dynamic's high-end headphones are a boon for audiophiles.

Razer's Nari exemplifies the gaming headset ideal: wireless, with all the trimmings.

Logitech has long been making 2.1 speaker systems designed for use with PCs.

## ROUND 4

### Comfort

If you're willing to shell out a significant amount of money, it's not hard to find a comfortable gaming headset. They're designed to be used for extended periods under potentially stressful conditions, often using breathable fabrics to keep your ears cool. Cheap out and you're going to be uncomfortable after an hour or two, though. Gaming headsets also tend to be heavier than audiophile headphones, due to the presence of a microphone and any other additions.

The stripped-back designs of many headphones mean that the manufacturer can focus on comfort, which is evident in many models: many Grado headphones use lightweight materials with open-backed ear cups designed for easy and comfortable listening. Gaming headsets almost always use closed-back cups, which leak less sound but cover the ear more completely, which can get warm and uncomfortable after a while.

Here's the thing, though. No matter how plush and impossibly soft the ear cushions are, it'll never compare to simply not wearing anything on your head and still being encompassed by rich, room-filling audio that can be enjoyed with friends: Nothing to wear, no cables running to your PC. This round is a shoe-in: Speakers win.

**Winner: Speakers**

## ROUND 5

### Features

When it comes to features, headphones fail hard. Sacrificing add-ons (and often aesthetics) for pure, unadulterated audio quality means that many offer a stripped-back experience; ideal for the person who just wants to listen to music, but not so helpful if you want to play games or use Skype. In-line microphones are a rare sight, while they're virtually mandatory for gaming headsets. Integrated media controls are also significantly more common on headsets. Speakers lose points here too due to their purpose-built nature, but claw back second place by virtue of features such as home assistant integration and voice controls.

So, headsets win again. With features such as hi-res audio and 7.1 surround sound making the jump to gaming headsets, a high-quality gaming headset is now packed with features. Tools designed to work in conjunction with a mic, such as chat mixing and background noise cancellation, are also becoming common. Gaming brands are also more likely to explore other gimmicks, like the HyperX Cloud Flight S and its wireless Qi charging capabilities. We could go on, but while not all of them are actually that useful, headsets surge to victory for sheer breadth of features.

**Winner: Headsets**

## And the Winner Is...

It's gaming headsets! The most versatile of the three, they offer portability and a wealth of features. Speakers and headphones are pretty useless for online gaming without a mic, whereas a quality gaming headset can be used for listening to music or taking part in video calls.

If you need a multipurpose headset, don't dismiss gaming brands. Sure, RGB lighting won't add anything to your home audio experience, but a Discord-certified microphone and customizable media controls might. It's also not hard to find super-portable headsets that can be packed into a carry case when you're on the go, and can connect to your devices wirelessly or with a cable.

However, this is a case of shopping with purpose; if you're not a gamer but work with music, high-end Sony or Shure headphones will serve you better than anything Razer or Steelseries can offer. If you live alone (or with music fans), consider 2.1 speakers—just don't be that person in Zoom who sounds like they're underwater because they don't have a noise-cancelling microphone!

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# DOCTOR

THIS MONTH THE DOCTOR TACKLES...

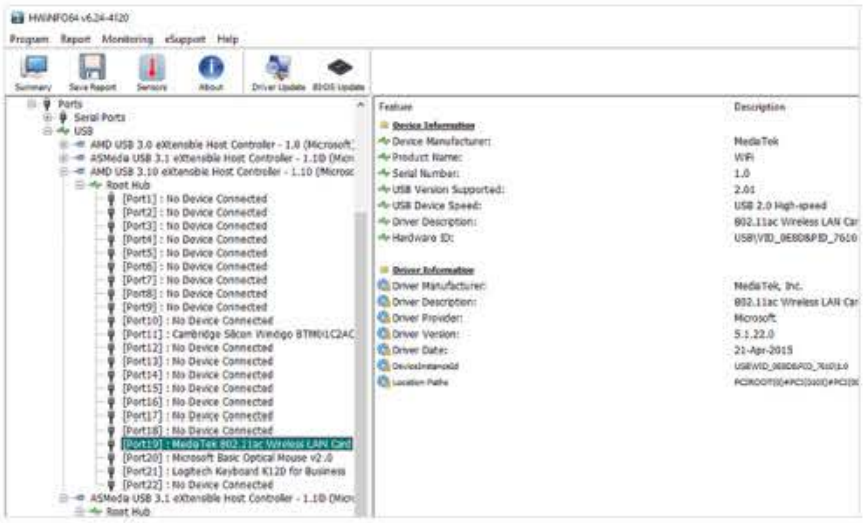
# > USB Problems
# > Filesystem Corruption
# > Pair With Bluetooth

## AMD USB Problems

I have an AMD R9 3900X build with an MSI X570 MPG Gaming Pro Carbon motherboard. I was having thermal issues with the voltage regulator modules, which meant the CPU was being throttled when the VRMs hit 95 degrees Celsius. I decided to replace the mobo with an ASUS ROG X570 Crosshair Hero VIII, which runs a lot cooler.

I originally stuck with the same Windows install, which settled down after several reboots and driver updates, but have now run into some weird issues. USB flash drives are only recognized 50 percent of the time when plugged into any USB 3.0 port, forcing me to unplug and reinsert them. Sometimes I get an error saying the USB device wasn't removed properly, even when nothing is plugged into it!

Also, when the PC starts, it occasionally boots to a blurry login screen, but the login box does not appear, so I'm forced to reboot. I had to disable Quick Start to get around this issue. Finally, Device Manager shows an error: "Unknown USB Device (Device Descriptor Request Failed)." I've tried uninstalling and disabling the device, but the error always appears.




**HWInfo can help isolate the cause of USB problems.**

I did a complete fresh install of Windows 10 Pro as a last resort. After the fresh install, the Windows errors were still present, so I'm thinking the issue may be the motherboard. I hope you can provide me with some guidance. Thank you.

**–Jon Shimamoto**

**THE DOCTOR RESPONDS:** It pays to pair a brand new mobo with a fresh Windows install—wiping the hard drive completely clean, then performing a factory-fresh install with no traces of any old systems left. The Doc assumes it's what you've (belatedly) done here.

The fact the problem has persisted means something isn't right, however. You could try RMAing the board, but an online search reveals numerous complaints about USBs on AMD chipsets. It means your issues could be down to anything from voltage settings or memory timings to drivers or USB power-saving settings. It's worth troubleshooting further before returning your board.

A good tool for tracking down the source of USB problems is HWinfo (www.hwinfo.com). In your case, the device descriptor error should point to a specific port—open HWinfo's main screen, then expand "Ports → Serial Ports → USB → AMD 3.10 eXtensible Host Controller—1.10 (Microsoft)." A list of all ports will be shown, along with the devices connected to each port. Selecting this should hopefully help you identify which device is causing the problem, allowing you to investigate further.

For more general troubleshooting, start by making sure you've got the latest BIOS update (dated March 20th) installed, and while you're at it, visit https://bit.ly/MPCAsus to see what drivers are available. If nothing shows up in the driver search, you may need to whitelist the site with your ad-blocker to make them visible. The obvious driver to install here is the chipset one, but there's been reports that these are less stable than the ones supplied by Windows, so consider rolling back to the Windows ones to see if that improves matters.

Finally, others have traced their problems to the AMD Ryzen power plan—it's not enough to simply switch to another plan, you need to remove the plan too. First, verify it exists: type "power plan" into the search box and click "Choose a power plan." If an AMD Ryzen entry is present, first switch to another plan (say "Balanced"). Next, click "Change plan settings" next to the AMD Ryzen plan and click "Delete

↘ submit your questions to: doctor@maximumpc.com

this plan" to remove it. If the problem persists, access your new plan's advanced power settings, expanding the USB section and disabling USB selective suspend.

## Fix Filesystem Corruption

My Windows 10 64-bit system was reliable for years, but then began to hang for brief periods. After a fruitless search, someone suggested it might be down to a bad spot on the drive—I ran "chkdsk" and it found an error. I re-ran it, instructing it to repair the problem—it finished, rebooted, and then told me the filesystem was corrupt. I used a recovery boot CD and expected to find that the drive was empty, but all my files are still there. I've tried searching for any utility that might fix the filesystem problem but found nothing. Is there anything out there that might be able to repair the filesystem?

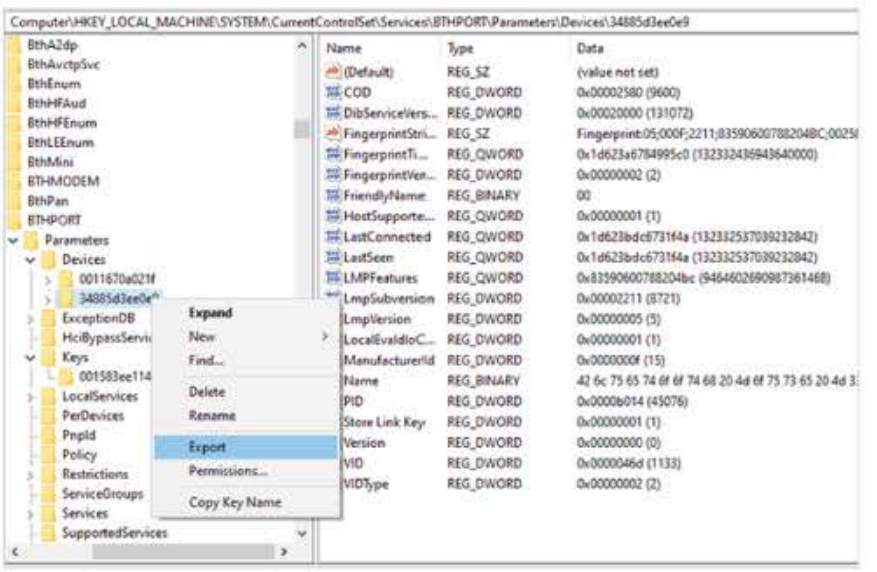
**–Bill Simpson**

**THE DOCTOR RESPONDS:** In an ideal world, we'd focus on recovering the specific program you want to save, but without knowing what it is we can't determine whether you need to recover a product key (which may be stored in the Registry) or source an installer for that specific version of the program in order to resurrect it—and that's before saving any configuration settings.

Consequently, the Doc will reveal a tool that enables you to take a fail-safe image of the entire hard drive before attempting to repair the filesystem using its own collection of tools. That tool is Lazesoft Recovery Suite (www.lazesoft.com/lazesoft-recovery-suite-free.html). Install it on a working PC and use it to create a bootable USB flash drive or DVD to run on your afflicted PC.

Once done, boot your troublesome PC from the rescue media. Start by selecting "Lazesoft Disk Image & Clone" and choosing "Drive to Image" to create a VHD image of the entire drive on a backup drive. If all else fails, you'll be able to access this VHD image in a number of ways—"mounted" like an actual physical disk using a free tool like OSFMount (https://bit.ly/MPCMount) to enable you to browse its contents and copy off individual items, for example. It can also be attached to a virtual machine using Virtualbox, or copied back to another hard drive (handy if you'd discovered your non-working PC's drive was physically damaged and needed replacing).

With this fail-safe backup in place, you can then return to the main Lazesoft menu and choose "Windows Recovery." Try the "One Click Fix" solution first—if it fails, undo it, then try "chkdsk" on the "BootCrash" tab, followed by "Check Partitions" and "Additional Tools → Run SFC." Still no luck? The "FinalSolution" will guide you through a Windows reinstall—you may be able to perform a repair install from here to bring Windows back again without losing any data or access to your program.




**The Registry holds the key to pairing a device to two installs.**

## Wipe or Upgrade?

I'm finally ready to ditch Windows 7 for Windows 10. I've downloaded the free upgrade to a USB drive following your column in the August 2019 issue. My question is how to prep for this upgrade. I've always wiped the hard drive to do a clean install. Since this free Windows 10 upgrade didn't come in a shrink-wrapped factory package CD with new registration code, must I install it on top of Windows 7?

**–David Marshall**

**THE DOCTOR RESPONDS:** Follow the Doc's advice and upgrade over the top of your existing Windows 7 installation—this will ensure that a valid digital license for Windows 10 Home is produced for your PC (after installation completes, open Settings and search for "see if Windows is activated" to confirm it's worked—at time of writing, you are still able to get a free upgrade). Once you've got that, and linked it to a Microsoft account, feel free to wipe the drive and reinstall Windows 10 from scratch.

## Pair Device Twice

I've got a Bluetooth mouse I'd like to use on a dual-boot system, but each time I pair it with one Windows 10 installation, it won't then connect to the other unless I perform the pairing dance again. Other Bluetooth devices don't have this problem—can I get the mouse to stay paired to both devices at the same time?

**–Jake Wilkins**

**THE DOCTOR RESPONDS:** Most Bluetooth mice (and keyboards) can only be paired with a single OS or machine at one time. Multi-device peripherals exist—for example, Logitech's MK850 combines Bluetooth mouse and keyboard with support for up to three devices.

You can, however, see if you can trick your Bluetooth mouse into thinking your two Windows installations are one and the same. This relies on both installations sharing the same Bluetooth dongle (if you're feeling brave, you may be able to adapt this to work on two separate Windows PCs, so long as you remember to swap the Bluetooth adapter between each machine).

Step one is to pair your mouse with the first Windows partition. Once done, repeat for your second partition. As things stand, the mouse works with partition two, but not partition one. While still in partition two, open "Settings → Devices" and click "Devices and Printers" to open Control Panel. Double-click your Bluetooth mouse to open a "Properties" screen, switch to the "Bluetooth" tab and make a note of its unique identifier.

Next, press Win + R, type "regedit" and hit Enter. Browse to the following key: "HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\BTHPORT\Parameters\Keys." Expand this, and you should find a subkey with a unique alphanumeric name (such as 001583ee1140) that refers to your Bluetooth adapter. Inside this will be a value that matches your mouse's unique identifier. Right-click the subkey and choose "Export" to save it as a REG in a location accessible to partition one. Expand the "Devices key" above "Keys"—you'll find a subkey that matches your mouse's ID. Export this key too.

Attach a wired mouse to your PC and reboot into partition one. The Bluetooth mouse will stop working, but import the two REG files you created (double-click each in turn and follow the prompts to merge them into the Registry) and reboot again into partition one. You should now have access in both installations.

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SCARLETT

WILLOW

ELLIE

GRAYSON

CHUCK

STELLA

SAVANNAH

ANTHONY

NOAH

CORA

# THE HOME-WORKING REVOLUTION

## Whether you have to stay at home or simply prefer to, **Maximum PC** is here to optimize your working-from-home life

**BY CHRISTIAN GUYTON**

**GREETING, LOYAL READERS.** The *Maximum PC* team remains in lockdown at the time of writing, but with the aid of technology we're adapting to our new working environment, and a host of apps, services, and specialized hardware is making it easier than ever.

This is leading toward a time where working from home is the preferred option for many, whether they've experienced it recently or have been fighting for it for years. Corporations and employees alike are finding that their jobs can, in fact, be done remotely.

We're here to help you work from home, whether that's during this accursed pandemic or beyond it. From the best ergonomic peripherals to the right way to use that video chat software your boss has been demanding you use, there are plenty of ways you can make your working-from-home lifestyle easier, more efficient, and more comfortable.

In this feature, we'll be covering the key apps and programs you'll need to stay connected to the outside world as you work from the comfort and safety of your own domicile. We'll take you through the hardware you might want, and the tips and tricks you'll need to keep your home functioning as a healthy work environment. We're also going to take a look at desktop work PCs, and how you can easily and cheaply build a system that's perfect for working from home.

Above all, we'd like to take this chance to thank all our readers for supporting us during this time. Producing the magazine from our respective homes has been an interesting experience, to say the least. *Maximum PC* benefits from a truly international team, both full-time and freelance, many of whom already work from home, and now we're eager to return the favor. So strap in (to your desk chairs), and let's go.

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**IF YOU'VE ONLY** transitioned to working from home (which we're going to refer to as WFH from here on in) in the past few months, it may feel like you've been dunked unceremoniously into a swirling vat of unfamiliar software that everyone is suddenly talking about. "What the heck is Zoom?" asked 17 million people around the world in late March. "Why have I never heard of Discord?" they cried.

In case you're somehow not in the loop, Zoom (much like Skype or Google Hangouts) is a video-conferencing service, ideal for those important face-to-face office meetings when not everyone can make it to the office in person. Discord is another service not unlike Hangouts, but more in-depth, allowing you to create private, customizable servers with different "rooms" for voice, video, and text communication. We're going to be looking at the advantages and disadvantages of each platform, as well as giving you a crash course in how to use them.

First up, let's talk about video calls. It's perhaps the most important aspect of WFH—both for that much-needed human contact, and for better communication with your colleagues when you can't meet in person. One-to-one video calls and video conferences are necessary in most professions to effectively work from home. You'll need a webcam and potentially some other hardware for this, but we'll get to that in a couple of pages. Software-wise, you have three main options for video calls on PC: Zoom, Hangouts, and Skype. Discord does offer video chat and screen-sharing, but it's less convenient to set up and use than the other software options here, so we wouldn't recommend it for professional use.

**Zoom prioritizes the video feed of whoever is making noise, so don't eat with your mic on.**

Zoom and Hangouts both offer comprehensive and effective services; Skype simply isn't as good, so unless your superiors are insisting upon using it, we'd steer clear. The *Maximum PC* team primarily uses Hangouts when we're WFH, so let's cover that first. As you may already know, Google Hangouts is available both as a mobile app or in a browser on a PC, and offers instant messaging and group video calls, with the former also being integrated into Gmail on browsers.

Hangouts's video-call functionality is solid and simple to use, with scheduled calls being automatically added to Google Calendar so you can join them with just a few clicks. Free conference calls are capped at 10 simultaneous users (with no time limits, which is useful for lengthy meetings), but for presentations with numerous viewers it's also possible to "stream on Hangouts,"

## SAFE AND SOUND?

**Since its surge to widespread renown in early 2020, Zoom has—entirely predictably—come under scrutiny and attack from a number of sources, be that political organizations or individual griefers. Security issues were quickly exposed and patched in a hurry, but many users still have concerns about the safety of Zoom connections.**

**Zoom expanded so rapidly that it became an immediate target; early on in the COVID-19 pandemic, British prime minister Boris Johnson was involved in a public gaffe when he posted a screenshot of a virtual UK government meeting over Zoom, but crucially forgot to hide the meeting ID and usernames of the participants. No matter how secure the program, human error is always the biggest danger to digital security, so be careful.**

**One way to reduce the risk of using Zoom is to access it through a secure browser like DuckDuckGo, rather than downloading the Zoom app. The browser version of Zoom can only act within the confines of your browser and is beholden to any security features built into that, limiting the amount of potential damage that could be caused if hackers attempt to pilfer your personal data. Early issues with the desktop app have been ironed out now (including one particularly disastrous vulnerability that allowed hackers access to the webcams of Zoom users on Macs), but it's always best to err on the side of caution.**

**Windows Defender can regularly scan your system for threats in Windows 10, and does a better job of doing so than many paid antivirus solutions, so be sure to make good use of it if you're now dealing with sensitive business information on your home computer. If you have to make video calls but are wary of being observed, simply unplug your webcam from your PC when you're not on a call. It's a rather simple, low-tech solution, sure, but it's also undeniably effective.**

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**Discord's mobile app is a full-featured piece of software.**

enabling numerous users to tune in to one video feed. Video and sound quality are generally beholden to the quality of your own home setup, of course.

## ZOOM IN THE ROOM

Next up is Zoom, the popular new kid on the block. It was already an effective tool but skyrocketed to widespread use early on in the COVID-19 pandemic. Prior to any lockdown orders, Zoom was primarily used on a corporate level, but has since expanded into areas like education, healthcare, and hobbyist meet-ups. Some therapists are now offering sessions over Zoom, teachers have met with their classes on the platform, and it remains ideal for large corporate meetings.

Zoom is available on both PC and Android/iOS, although the PC version has a free desktop app as well as being accessible via browsers. Zoom's free tier caps video meetings at 40 minutes, although the video call participant cap is 1,000, making it the clear choice over Hangouts if you regularly host meetings with 10+ colleagues. 49 concurrent video streams can be active at once, and Zoom's nifty behind-the-scenes technology can automatically prioritize the video of whoever is talking, ensuring that you can tell who is speaking over a bargain bin microphone. The screen-sharing function that is now available in most video call clients is present in both Hangouts and Zoom, but only Zoom lets multiple users share their screens at once.

Zoom is a tad more complex to use than Hangouts, with useful features like note-taking tools and automatic voice-to-text transcription that manages to register speech with surprising accuracy. Hangouts benefits from full Google integration; if you already use Gmail, Google Drive, and Google Calendar, Hangouts will work seamlessly. If you (or your company) uses other systems, though, Zoom may be the better option. Zoom requires you to create a dedicated account and lets you create and schedule video meetings, either in the desktop client or on the Zoom website. Neither Hangouts nor Zoom lets you record video meetings without paying to upgrade your account.

**The green hangouts icon can be found with the app pre-installed on many modern Android phones.**

## TYPE CAST

For text chat, we use Slack and Discord (you can join the *Maximum PC* Discord serverat bit.ly/MPCDiscord), the latter of which also offers audio "rooms" and video calls similar to those of Hangouts. Slack is a straightforward, professional IMS, keeping clutter to a minimum and letting you easily create channels within which different topics can be discussed. It also links to a number of other third-party tools (like Outlook and Google Calendar) for ease of use. The free model of Slack has a limit on how many messages can be stored, deleting old messages once you hit the limit, but we've never found this to be a problem.

Discord is a fantastic suite of communication tools, but we wouldn't recommend using it for the stuffier corporate calls. There's a reason it's popular within the tech community: It was originally designed for gamers to keep in touch and communicate with each other during intense online games, be

## FOR SCIENCE!

**The resources offered by Folding@Home have led to several successful developments.**

If you haven't heard of Folding@home, you're not doing your part to help mankind fight disease. At the bleeding edge of medical research, incredible amounts of processing power are needed to crunch the numbers and run the simulations that help researchers develop new medicines and treatments for a huge variety of ailments, and the need for this power is only ever expanding.

Not every scientific research team can afford a supercomputer, though, so distributed computing projects are the next best thing: A vast network of systems around the world, volunteering surplus memory, CPUs, and GPUs to help chip-in to help solve massive, complex problems.

Folding@home is one such project, leveraging the power of thousands of idling computers to simulate protein dynamics and aid in the fight against everything from Alzheimer's to prion diseases to COVID-19. Popular looter-shooter *Borderlands 3* started a similar project recently, where completing a minigame helps map out the human gut microbiome.

F@H is solely reliant on volunteers independently allowing the program to access and utilize their system. It's a relatively simple process: Small work orders are created from chunks of a larger simulation and sent out to participating computers, which complete them and then return them to the central database servers before receiving more. The project is based out of Washington University in St. Louis, but anyone in the world with an internet connection can set up their system to contribute. Online leaderboards and "teams" of participants add a competitive element to the number-crunching, with cadres of PC-building enthusiasts often lending the power of their PCs to score points. If you're thinking about participating—and it's super easy to do so; just download the tool from the F@H website—then why not show your colors with the *Maximum PC* crew at team #11108?

© DISCORD, GOOGLE , THE F@H CONSORTIUM

that competitive esports matches, or epic, 40-player raids in MMORPGs.

The slightly frustrating crux of the matter is that despite featuring basically every element that we expect from the other software listed here (customizable channels within private servers, multi-user video calls with screen-sharing, audio rooms with unlimited user capacity, even moderator-controlled chat bots), Discord is and always has been insistent on adopting a particular aesthetic and UI that can only be described as "mid-2000s gamer cool." The startup screen lists popular games, funny (often cringeworthy) messages pop up while the app loads or updates, and any friend requests you send are "escorted by elite Discord samurai."

The fact is that Discord simply isn't that professional. A "business" mode for the software has been floated by users many times over the last few years, but the developers don't seem to be interested. It's a shame, as Discord is a feature-rich alternative to Slack and Hangouts, and doesn't lock the majority of its features behind a paywall. If you're lucky enough to have a relatively casual work environment, or you're more interested in keeping in touch with friends, it's still worth a look.

## GRAB SOME GEAR

Having the right hardware can make your WFH experience more efficient and productive, not to mention making you the envy of your colleagues. There's a huge amount of options here, so we're going to start with peripherals, but we'll get to talking about system upgrades later on too. We'll skip over keyboards and mice, since we'd like to hope that you already have one of each that suits you. If not, how on earth have you been using your PC?

**The Razer Kiyo's ring light is great for keeping your face illuminated during an evening video call.**

All of the peripherals we're going to talk about are useful, but webcams are an absolute necessity. If you're taking part in regular video calls or streams, having a good-quality webcam is a must. Ironically, the best webcams around are mostly gaming models designed for Twitch streamers rather than office workers, but that doesn't make them any less effective. The Razer Kiyo, for example, offers 1080p video with a bright

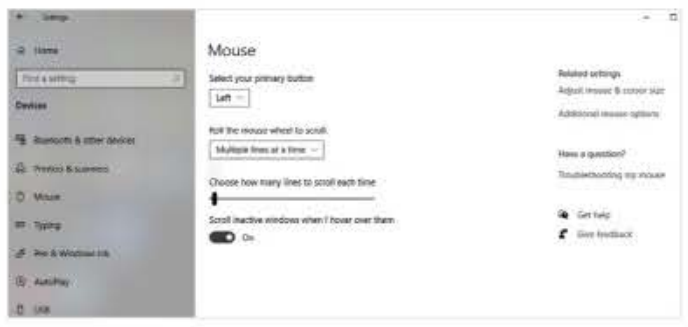
**The right gear and setup for your environment can make a huge difference when WFH.**

## WFH: WINDOWS FREAKING HELPS

**Windows 10 is a powerful and versatile operating system, and it's important to make the necessary changes so that it can better support you when you're working from home. If you prefer to work after dark, the removal of brightness adjustment in desktop PCs running Windows 10 is a pain, but there are plenty of lighting solutions you can use. F.lux is a free download that lets you adjust both the brightness and color temperature of your display. RedShiftGUI is another, slightly more basic option.**

**Focus Assist is a Windows 10 feature that can be helpful and frustrating in equal measure. It's easy to tweak so that it'll only alert you to new notifications and alarms inside of specific hours, or not at all. It's worth checking it out under the system settings and adjusting it to suit your needs. If you're the type to keep numerous windows and browser tabs open, you should also check out the "Multitasking" tab, as it lets you adjust the way non-maximized windows and virtual desktop pages behave.**

**We've already mentioned Windows Defender, but there are plenty of other handy little tools squirrelled away inside Windows**


Mouse
Select your primary button
Left
Roll the mouse wheel to scroll
Multiple lines at a time
Choose how many lines to scroll each time
Scroll inactive windows when I hover over them
On

**Tweak settings like scroll speed until you've found the sweet spot for your preferred experience.**

**10. Storage Sense (under "System → Storage") can be used to quickly free up space on your drive, which can be useful if you're still rocking an old HDD.**

**Lastly, check out how Windows is treating your peripherals under the "Devices" menu. One useful setting to tweak is how many lines your mouse will scroll through per scroll wheel rotation, which you may want to raise or lower depending on the resistance of your mouse's own wheel. This writer prefers a firm, "clicky" scroll wheel that snaps through a decent chunk of text with a single short movement, but if you prefer more precise control, tune it here.**

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LED ring light—ideal for if you're making video calls in a poorly-lit space. We'd advise against getting anything below 720p resolution: 1080p is perfect for Zoom and Hangouts.

However, the brand we'd truly recommend for webcams is Logitech. With a huge range of plug-and-play (plug-and-work?) webcams that suit every budget, everyone should be able to find a Logitech webcam that suits their needs. The C270 is an excellent option if money is tight, while the Logitech Brio is a dazzling 4K option for those with money to burn. If Logitech doesn't tickle your fancy, you might want to check out Microsoft's own webcams, like the eminently professional Lifecam Studio. Some webcams come equipped with Windows Hello compatibility, which is worth looking out for as it makes logging into your PC each morning faster and easier.

Many webcams have an internal microphone for picking up audio, but you SHOULD NOT USE IT. Much like integrated speakers on a monitor, these mics are rarely any good, and it's a simple enough business to replace them with a dedicated freestanding mic, or a headset with a boom microphone. It's important to ask yourself if you really need a freestanding mic, though; Brands like Blue, RØDE, and Razer all offer outstanding audio clarity, but if you're working in a quiet room you should find that a good-quality headset mic works just fine. Regardless of what mic you're using, make sure that you don't play call audio out loud through speakers; this can cause feedback that will annoy your fellow call participants. If you're producing feedback despite wearing a headset, you may need to turn down the sensitivity of your microphone.

**Microsoft's LifeCam Studio is the ideal corporate webcam, thanks to a broad field of view and wideband mic with good sound quality.**

## HEADY, SET, GO

When it comes to headsets, once again you may find that the best options are gaming brands. Thankfully many of these look professional enough to wear on a work video call, such as Steelseries's excellent Arctis line or the Cloud headset series from HyperX. Look out for the "Discord Certified" badge when comparing headset mics; this means the mic has passed a series of audio clarity tests for voice chat over Discord. Pay attention to the pick-up patterns of mics too; omnidirectional mics will pick up sound from everywhere, which can make background noise worse, while a cardioid or unidirectional pattern should only register your voice. If you already have headphones but no mic, consider investing in the fantastic AntLion ModMic, it's an effective miniature boom mic that attaches to the side of your headphones and is a cheap inexpensive solution.

**Netgear Nighthawk routers offer dual-band connectivity and look like stealth bombers.**

When it comes to monitors, it's all about personal preference. BenQ, AOC, Acer, and Asus all produce high-quality displays in a variety of sizes, so it's important to consider what you're going to be using your monitor for. There's no need to buy a 4K display if you're running an old PC with integrated graphics, but if you game as well as work on your desktop, you may want to invest in a better screen. If you work with digital art or photo/video editing, ensure that you've got a display with good color density.

One key question surrounding monitors is the notion of dual-screen setups. Two

# A SCANNER CHEAPLY

**Do you need a printer, scanner, or copier? These days, those three are almost always contiguous: Modern printers contain the necessary technology to digitally scan and copy whatever documents you might choose. Think carefully about whether or not you need one, though. Many employers have moved steadily towards digitization over the past two decades, and old-fashioned paper files are on the way out. Let the door hit them as they go, we say.**

**Our advice would be to not get a printer unless you absolutely need one. Even modern units are bulky, heavy, and usually quite loud—and don't even get us started on the cost of printer ink. However, there are situations that necessitate a printer, such as printing labels for packages or leaflets for distribution. If you can't access your usual printer in the office (or a local library), then buying a printer-scanner-copier may be the right call.**

**It's important to match the product to the purpose, of course; if you just need to print off the odd letter, make sure you buy a compact printer that you can easily store out of the way when not in use, like the LaserJet Pro M15w or Envy 5055, both from HP. The M15w is very reasonably priced, although it's worth noting that it doesn't offer automatic duplex printing. However, if you expect to be churning out documents just like you would at the office, investing in a heavier-duty model might be a better call, and the Epson EcoTank ET-3760 isn't pretty, but it's very ink-efficient and not too noisy. Alternatively, if you've really got money to burn (or a work-issued ink budget), the Ecosys P5026cdw printer from Kyocera powers through large duplex print loads without making much of a racket—just do yourself a favor and be sure to keep abreast of how fast you're burning through those ink cartridges, OK?**

**The HP Envy 5055 is compact and sits in the middleground of printer pricing, making it a safe bet.**

© NETGEAR, HP

displays side by side can increase productivity for some users, but be careful: If you already have a 30-inch widescreen monitor, you don't need a second screen. Two 24-inch or 27-inch displays are a good call for a dual-screen setup.

Such setups are easier to, well, set up, than ever before, requiring just the monitor and an extra HDMI or DisplayPort cable. Windows 10 has made it easier than ever to control multiple monitors: Just go to "System Settings → Display → Multiple Displays" to set your primary display and adjust both screens. If you select "Extend these displays," Windows will begin to treat both screens as one display, allowing you to seamlessly move between the two.

**The Yeti series of microphones from Blue guarantee excellent audio clarity.**

## CONNECT AND CONTAIN

Internet connectivity is a hot issue during a pandemic lockdown. With more people WFH than ever, some ISPs are creaking under the weight of the extra online traffic. There isn't much you can do about that, but upgrading your router may help—especially if you live in a busy household with multiple internet users. Netgear and TP-Link have plenty to offer here, whether it's the home-assistant router Orbi from Netgear, or TP-Link's powerful Archer line. Routers that offer multiple connection channels (dual-band or tri-band Wi-Fi) are ideal for this, as you can hop onto an unoccupied channel and enjoy lag-free video calls while the rest of your household uses a separate band.

At-home digital storage solutions are another key element of WFH, especially if you regularly deal with large files in your profession. If you just need to back up and store your own files, large external hard drives aren't too expensive; check out Western Digital's wares. However, if you want your own, more secure storage solution that can be accessed from anywhere, you may want to invest in buying (or building) a NAS system. For this, TerraMaster's F-series NAS boxes offer good-quality personal cloud storage that is easy to use and won't break the bank.

## HOME IMPROVEMENTS

Beyond your PC, there are plenty of ways to improve your home to better suit your work lifestyle. It goes without saying that if you have a separate room you can use as an office space, you should, but we're going to cover plenty of tips that can be implemented anywhere in your home, even if you prefer to (or have to) work from your bedroom or living room. Speaking of bedrooms: Never work from bed! It won't help your productivity, but it will likely make your back hurt.

**The Noblechairs Icon costs $330—a small price to pay for back salvation.**

First up, you need a desk. Working at the same table you eat at, particularly in a busy household, isn't a good plan. It doesn't have to be anything fancy: A small flat-packed desk from Target is fine, or even just a wooden worktop atop two Ikea cabinets. There's no need to spend a lot of money setting up your home for working. A bit of DIY will save you money—if you can make it yourself, you should.

Maximizing your storage space can also be useful when WFH, as the *Maximum PC* team has found, with hardware stacking up inside our homes. Wall-mounted shelves or cabinets add storage space without compromising floorspace, and can be easily assembled yourself using long planks of wood and pipe-shelving brackets, both of which should be available from local hardware stores or online. Ground-level storage that can fit under beds and couches is also a great option, with large plastic containers costing very little from online retailers.

## TAKE A SEAT

Once you've got your desk area sorted out, you'll need a good desk chair. There are plenty of good options here, and once again gaming rears its head. Gaming chairs are specifically designed for sitting in front of a computer for hours on end, and as such focus

## UPGRADE YOUR WFH RIG

**If you're stuck at home, there's no better time to upgrade an old PC and turn it into an ideal work machine. The necessary hardware for running common WFH software like Zoom is relatively minimal—four to eight gigabytes of RAM will suffice, along with a CPU that is dual core or better. If you've got an ancient system knocking about, now might be the time to salvage what parts you can and transplant the system into a new case with a few upgrades.**

**Upgrading the memory on an older system is a great way to improve its capabilities.**

**Alternatively, you may want to consider snagging a GPU for any system running on integrated graphics, if only to make dual-screen setups run smoother. If your work typically involves any demanding software use (for example, the Adobe Creative Cloud suite or Blender), you're going to need a PC that can handle it, especially if you're accustomed to using a powerful company-owned PC or Mac in your office. Building yourself a true workstation PC may prove challenging until the world has shaken off the effects of COVID-19, since many components have been hit by stock and supply issues due to the outbreak, but there are plenty of alternatives floating around. Consider checking out AMD's GPUs if you can't find the GeForce model you want. Don't be afraid to buy a new CPU, even if it means replacing your motherboard.**

**You might even decide that you want an extra system to keep your productivity up. Right now, you can pick up AMD's Athlon 3000G for barely 50 bucks. It's a dual-core budget beauty with Radeon Vega 3 graphics that'll easily carry any system hooked up to a 1080p monitor for video calls. Pair that with the free included cooler, a cheap B450 motherboard, and 2x4GB of DDR4 memory, and you've got the baseline for a great budget secondary system for less than 150 bucks in total.**

**Having a system that can handle what you're asking of it will definitely make your working life smoother and less stressful.**

© BLUE, NOBLECHAIRS

**Seriously, get yourself a house plant. It's good for you.**

on ergonomic support and cushioning to prevent cramps or joint pain. If you can afford it, Noblechairs offers incredibly high-end computing thrones, in particular the Hero and Icon chairs. Somewhat cheaper but still good are GT Omega's "racing" chairs, originally designed for racing simulators but equally well-suited for long WFH hours.

A well-lit work environment is another must, both to keep your skin healthy and reduce eye strain from staring at screens. Avoid working when the only source of light is your monitor! Ideally, you'll have a window to let natural sunlight in during the day; this is always the best option, although remember that during the summer ultraviolet light is still a threat to your skin. It's also worth opening your window to let some air in, provided the weather outside isn't frightful.

If you're working outside of daylight hours, or your workspace doesn't have great natural lighting, make sure that your artificial lighting is sufficient. Don't cheap out on bulbs for your existing light fittings, and try to have different levels of illumination—whether that's dimmer switches or a smaller desk lamp to go with the ceiling light. LED strips are a great, cheap alternative to lightbulbs, and look great when positioned out of sight underneath desks and behind monitors. RGB LED strips let you change up the mood of your work space, and setting it to white-blue helps to alleviate some of the potential sunlight deficiency.

### THE LITTLE THINGS

There are plenty of small accessories that can make WFH easier, too. A wireless Qi phone charger on your desk lets you easily pick up and use your phone without having to worry about cables, and cable routing solutions are also worth examining if you've got a relatively crowded setup. If you've got a lot of plugs, buy surge protectors or risk angering the electrical gods. VESA wall mounts for monitors can be very useful if you use your desk area for written work too, letting you easily shift your display neatly out of the way against the wall.

Lastly, get yourself a house plant (even if you have a garden to tend). While the physical benefits are good, with a decent-sized leafy pot plant helping to aerate a room, the mental benefits shouldn't be underestimated. A house plant is something to look after and nurture, giving you an extra element of routine and something to add some natural color to your living and working space. However, we're starting to sound a lot like interior designers now, so we're going to call the home environment advice a day.

## SELF CARE

**Working from home has plenty of benefits, but it's undeniable that it can have deleterious effects in the long term. It's important to look after your physical and mental health when you're not going out to your place of work every day, and if you're not careful you may find that your productivity actually decreases. Sticking to a regular work schedule is the main draw here: Just because you don't have to get up at seven to catch the train to work, doesn't mean you should be sleeping in. Don't feel compelled to get up as early as you would normally (cutting out travel time will afford many commuters an extra hour or more of valuable sleep), but if your shift starts at nine, always aim to be ready to start work by that particular time.**

**Be sure to raise the warmness of your display and keep another gentle light on if you're working late.**

**Remember to take regular breaks to stretch, eat, and socialize with others in your household, especially if you're spending all your time staring at a computer screen. Schedule regular digital meetings with your co-workers and stick to them: Our team meets via Google Hangouts every Monday morning, no matter where we are. Face-to-face interaction (even if it is through a screen) is vital for keeping your social skills active, especially if you happen to live alone.**

**Work attire is optional; wearing your comfiest clothes is one of the big benefits of working from home, although we'd advise against spending the whole day in your pajamas. Shoes are also optional, but they may be worth putting on to keep a routine.**

**Non-optional, however, is hygiene. Shower regularly, use deodorant, and put on fresh clothes, especially if you're leaving the house. It's easy for days to blend together when you're working from home full time, and the last thing you want is to end up smelling like a *Maximum PC* writer after six hours under the photography lamps in the Future studio!**

© GETTY IMAGES

# $535 BUDGET BUILD

## When it's not about gaming, just what can you get on a budget?

**AT *MAXIMUM PC*** we do perhaps lean a bit too heavily on the gaming angle. That's no doubt in part because a large majority of the team here enjoy that pastime, and the industry advances quite aggressively because of it too. So we assume you lovely folks are fond of gaming, but as old pappa Storey used to say, "Never assume anything, else you're an idiot." He may have been a bit unorthodox, and lacked a smidge of accuracy with his clichés, but he was also right when he said it.

So this issue we've decided to set ourselves a challenge—strip everything down and get back to the basics of what makes a PC a PC. We're not building a gaming rig, an expensive high-end dream machine, or a workhorse rendering station, but instead a work pc, an everyday PC: A system that performs well, looks good, is affordable, and can handle those daily tasks the majority of us spend most of our time doing.

There's one caveat: We wanted to do this without compromising on quality, or setting ourselves some arbitrary cost number to hit. It's not about hitting a specific budget—although of course we have to advertise it like that—or hitting x frames in y benchmark. It's about building a system that's right to use on a daily basis. And integrated graphics have come such a long way, you could do a bit of casual gaming on the side anyway.

So how did we find it? Well, it's been quite the ride, and surprising as to what you can get for a fairly minimal outlay. OK, we're not including peripherals or a monitor here, and this is costed just to the base system itself. But for $535 we nabbed a quad-core, eight-thread processor, 16GB of high-spec DDR4, and a 1TB M.2 PCIe SSD, rated for 1800 MB/s sequential read and writes. How did we do it? Well let's dive in.

BUILD IT PG.32

## BUDGET BUILD INGREDIENTS

| PART | | STREET PRICE |
|---|---|---|
| CPU | AMD Ryzen 5 3400G | $149 |
| Mobo | ASRock B450M-HDV Micro ATX | $69 |
| Memory | 16GB (2x 8GB) Corsair Vengeance LPX @ 3200 MT/s | $74 |
| Storage 1 | 1TB Intel 660P M.2 PCIe 3.0 SSD | $120 |
| PSU | 600W EVGA 100-W1 -0600-K1 80+ | $60 |
| Case | Phanteks P300 ATX Mid-Tower Case | $63 |
| **TOTAL** | | **$535** |

PRICES CORRECT AT THE TIME OF PRINTING

***MEMORY***

## 16GB (2X8GB) CORSAIR VENGEANCE LPX @ 3200 MT/S *$74*

Memory prices may have been skyrocketing a few years back, but now it's a whole other ballpark. 16GB of high-speed memory for just $74? Count us in. Ryzen's infinity fabric interconnect (the stuff that connects the core complexes in the die) runs at the same speed as the memory. Ryzen 3rd gen typically disconnects after 3600 MT/s, but as our Ryzen 5 3400G is running on the old 2nd-gen architecture, it's not quite as quick, and only sees benefits up to 3200 MT/s. For our Intel solution, you'll have to opt for slower memory, as the ASRock B365M-HDV is only rated to support up to 2666 MT/s.

***CPU***

## AMD RYZEN 5 3400G *$149*

**Yep we've gone with AMD for this build, purely because its Ryzen APUs are fairly competitive when it comes to both cost and performance. With four cores and eight threads lined up over two core complexes, it's a fantastic chip for those looking to build something that'll work on a budget. Alternatively, if your heart's set on Team Blue, you could opt for an Intel Core i3-8300 for about $142, but you'd lose access to that hyper-threading, meaning you'd only have four cores, and you'd have to put up with slightly inferior integrated graphics performance compared to Intel's 9th-series processors.**

***MOTHERBOARD***

## ASROCK B450M -HDV *$69*

**With support for up to two sticks of DDR4 at 3200 MT/s, an M.2 slot for our PCIe drive of choice, and a full-size PCIe 3.0 slot if we decide to upgrade in the future, this ASRock B450M-HDV is absolutely perfect for our build, especially for $69. That said, it is a bit light on the rear I/O side of things. You get four USB 3.0 ports, two USB 2.0 ports, Gigabit Ethernet, three-channel audio, HDMI, DVI-I and VGA out, and a PS/2 combo port as well. For the intel enthusiasts, ASRock's B365M-HDV is a perfect pairing for the Core i3-8100 above. It's almost identical to the B450M featured here, but it only supports memory up to 2666 MT/s.**

BUILD IT PG.32

### STORAGE 1

## 1TB INTEL 660P M.2 PCIE 3.0 SSD *$120*

Now first let's start by saying this isn't the best PCIe 3.0 drive in the world. It's based off of QLC NAND flash tech, which is a heck of a lot less impressive than the alternatives. It's got lower overall endurance and slower performance than the likes of SLC, MLC, or TLC flash. That said, there's no denying just how much bang for the buck you get. We're talking sequential read and writes up to 1800 MB/s, making it a fairly proficient budget drive for those not looking to render massive video files on a daily basis. Combine that with a fairly helpful 1.6M hours mean time between failures, and it's perfect for everyday office use.

### CASE

## PHANTEKS ECLIPSE P300 TG *$63*

**Another budget-busting part is this fantastically well-rounded chassis from Phanteks. For $63, you get a small mid-tower chassis equipped with tempered glass, a tiny smidge of RGB, a full-size PSU cover, and support for up to a 280mm AIO in the front if you so desire. There's even a suitable amount of cable management around the back too, and it's available in multiple color schemes. The only downside? It comes with a single 120mm fan, but that's not the end of the world. Flip it to act as an intake, and you're good to go. OK, let's stop gushing about this case and move on.**

### POWER SUPPLY

## 600W EVGA 100-W1-0600-K1 80+ *$60*

One thing you can't go wrong with is an EVGA power supply. The company has a legacy for top-quality warranty and customer support, so if things do go wrong later down the line, you can rest assured it's got your back. This PSU is a non-modular, 80+ rated power supply and should be ideal for our aspirations here. We're expecting this pc to draw around 145W from the wall under load, meaning we've got a good 75 percent additional capacity on top of what's available. Heck, even if you added an Nvidia GeForce RTX 2070 Super you'd still only be looking at 361W under load—although we recommend you don't do that, as the Ryzen 5 3400G only has x8 PCIe 3.0 lanes for graphics cards.

© AS ROCK, INTEL, EVGA

# BUILDING ON A BUDGET

## A STEP-BY-STEP GUIDE TO PUTTING THE PERFECT $535 BUDGET PC TOGETHER

LENGTH OF TIME: **1-2 HOURS**

LEVEL OF DIFFICULTY: **EASY**

## 1 CASE UNBOXING

**SO HERE WE HAVE IT**, our Phanteks Eclipse P300. What Phanteks has achieved here is impressive. We reviewed it back in 2018, and it's still one of the better budget cases out there. At the time of writing Newegg is even running a $10 rebate on this. For that, you get support for up to a 280mm AIO cooler in the front, a tempered-glass panel, full-size PSU cover, ample cable management, a fleck of RGB, and fairly good airflow too. It's not perfect, but at this price, it kind of is.

Where does it fall down? Well some of the materials used on the inside are prone to fingerprints, it can be a bit tight to work in, and of course it only comes with a single 120mm fan as standard—but then again, it's $63.

## 4 FAN RELOCATION

**THIS MAY SEEM** like a trivial thing, but we've opted to move the fan to the front of the chassis instead of its default location in the rear. We're big supporters of positive pressure systems, and although there's only one included fan, having it act as an intake to draw cool air across the CPU heatsink is going to do this build a world of good.

That said, it's our biggest caveat for this case—not enough fans. If you've got a spare 120mm fan kicking around, throwing it in the front as well will help a lot. Positive pressure in a case ensures that cool air is drawn in through dust filters, and then hot air is pushed out through unfiltered areas. That helps reduce dust build-up inside your system.

## 2 CHASSIS STRIPDOWN

**THIS IS A PIECE** of advice we continually tout when it comes to building PCs, and with good reason, as it makes things so much easier. Strip down your case—the first thing you should always do is remove as much of the chassis as possible so you end up with a hollow skeleton. Not only does it mean you won't damage the panels, but it's also far easier to get your hands into all those tight nooks and crannies.

It's also a good opportunity to shave weight and improve airflow by removing things such as the hard drive cages and caddies, and unnecessary disk bays and things like that. Just remember where you put them if you do decide you need a 3.5-inch drive later down the line.

## 3 MOTHERBOARD INSTALL

**WE TYPICALLY DON'T** recommend you do this for most builds, as it's far easier to install your main components (CPU, RAM, SSDs) outside of the case first. However, in this build we're making an exception, as the system itself is fairly simple to put together and there's no additional AIO backplate or frustrating heatsinks to deal with for the M.2 drive.

One big difference between this system and the builds we usually produce is that this has a separate I/O shield. Always remember to install this first. Then it's a case of placing the motherboard in, making sure you don't trap that stock fan cable, and securing it down with the included motherboard screws that you'll find in the case accessory box.

## 5 AM4 INSTALLATION

**NOW WE CAN** take the opportunity to install our AMD Ryzen 5 3400G processor. To do this, simply lift up the retention arm on the AM4 socket, take your processor, identify the gold triangle located on the bottom-left side of the processor, line it up with the triangle on the socket, and carefully lower it down, lining the pins up with the holes in the socket itself. Once placed in, give it a tiny wiggle with your thumb to make sure it's secure, then lower the retention arm back down and into position to lock it in place.

## 6 FRONT PANEL CONNECTORS

**IT'S TIME TO** get the front panel headers in. The Eclipse P300 doesn't have the best front panel I/O, but for cabling all you've got to worry about is an HD audio passthrough, a USB 3.0 cable, a power button cable, and an HDD LED cable.

Installing those last two can be a bit tricky. The HDD LED cable needs to be plugged in a certain way so that the positive and negative terminals are in the correct position. However, for the power it doesn't matter, as its job is to bridge the two pins. Our ASRock B450M-HDV has the pins labelled on the board itself, but if yours doesn't, check your motherboard's manual. For the HD audio passthrough, that's always located on the bottom left-hand side of the motherboard, and for the USB 3.0 port, you'll find it has a notch in the cable, so you can install it correctly. We're also plugging in our front 120mm fan on the bottom of the board into a chassis fan header. Again there's a notch in the cable.

## 7 INSTALLING INTEL'S M.2 PCIE SSD

**INSTALLING AN M.2 SSD** is one of the easier things you can do with a system build. Simply use a small screwdriver to remove the screw at the end of the M.2 socket itself. Slot the M.2 drive into place (making note of the location of the notch on the drive), carefully push the drive down on top of the pin at the other end, and resecure it with the screw you removed earlier. And you're done—no finicky SATA power cables, cable routing, or drive mounting. Nothing.

## 8 HEATSINK IN PLACE

**WITH THE M.2** in, it's time to install the included cooler. AMD's Wraith coolers are seriously impressive units and come with a fairly foolproof mounting system. Remove the plastic cover that protects the base of the cooler—this is protecting the pre-applied thermal paste already on the base of the heatsink. Then, remove the two brackets situated above and below the socket, hold onto the back plate, behind the motherboard, carefully place your heatsink on top and secure it in a diamond or diagonal pattern. Carefully secure one corner down at a time with a screwdriver, making sure you don't go past the thread itself.

Now tidy up that PWM fan cable. Tie it into a little loop, then plug it into the CPU fan header at the top of the motherboard.

## 11 24-PIN CABLING

**WE'RE GETTING TO** the final stages of the build now, and things are starting to finally wrap up. All we have left to do is install the power supply cables. That's the 24-pin motherboard ATX power, and (in this scenario) a single four-pin EPS power for the CPU. Our B450 motherboard doesn't require too much juice to run. Fortunately the Phanteks Eclipse P300 comes with ample cable management, so it's not too difficult to run them up and around.

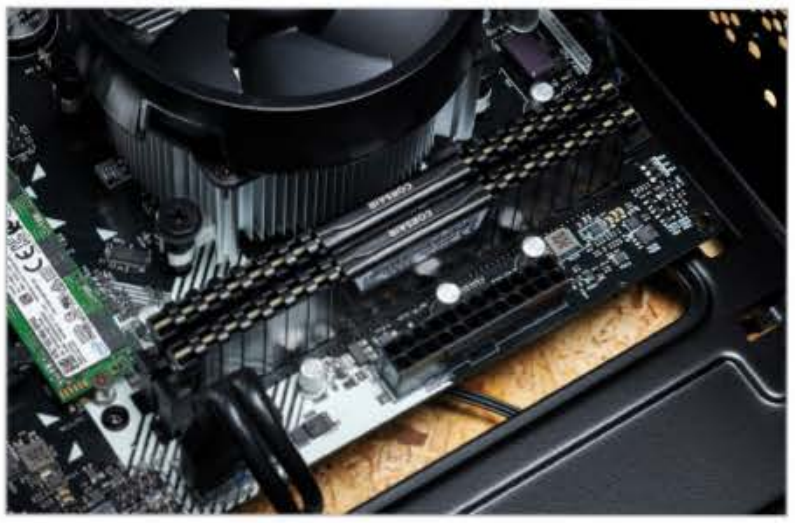
## 12 REAR CABLE MANAGEMENT

**AND HERE'S A SHOT** of the rear. You can see we've tucked the majority of our excess cables out of sight down below where the hard drive caddy is, and then just routed the main power cables in a direct line to where they need to be. There's nothing fancy going on here, and we've still got space to add some 2.5-inch or 3.5-inch drives if we want to, after the fact.

## 9 DDR4 ON BOARD

**OUR MEMORY** of choice here is this 16GB dual-channel Corsair Vengeance DDR4. The Vengeance line is a bit more budget-oriented, but this kit still packs in some impressive timings and an impeccable frequency. Ryzen's Infinity Fabric interconnect runs at the same frequency that your memory operates at. It's to do with the memory controller. Because the fabric interconnects with the core complexes, having it operate at a higher frequency means cores across those complexes can transfer data and process requests faster.

With 1st and 2nd-gen Ryzen, you'll see benefits up to 3200 MT/s. With 3rd-gen Ryzen, that goes up to 3,733 MT/s, after which point the memory controller and the Infinity Fabric disconnect, and you'll no longer see performance gains.



## 10 PSU ORIENTATION

**WHEN IT COMES** to installing the power supply there's not a whole lot to it. Simply slot it in the back of the case, line it up, and secure it down with the four screws included in your case's accessory box. One thing worth noting is that you will have to make sure the fan is facing down toward the bottom grill/filtered area, as the PSU cover itself doesn't have any ventilation cutouts facing towards the motherboard.

That's great for power-supply longevity, as you're not dumping excess hot air into your componentry there, but the downside is that when you have so few fans in a case like this, it would be good to use it as an additional exhaust.

## 13 BUILD COMPLETE

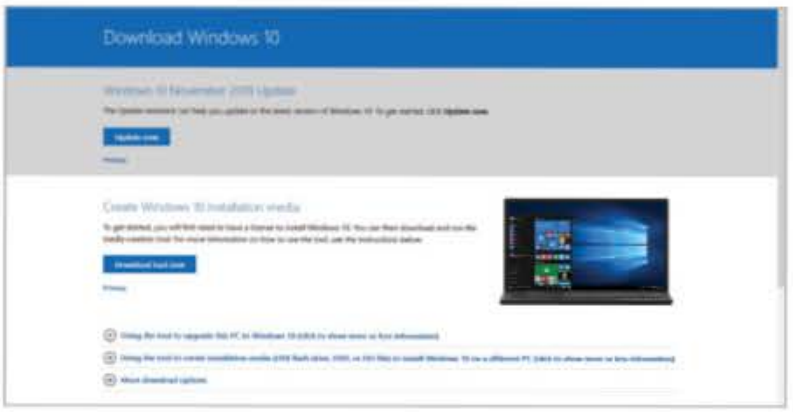
**AND THERE YOU HAVE IT**, one complete system ready to go. For just over $500 you get access to a 1TB PCIe 3.0 SSD, 16GB of DDR4 3200 MT/s dual-channel memory, and a hefty four-core, eight-thread processor. There's a fleck of RGB thrown in too (controlled via a button on the top of the I/O).

This is a really nice build for those not looking at that gaming angle. For office work and day-to-day use, it's going to be quick and to the point. The only major difference is the lack of a dedicated GPU. The Eclipse P300 is a fantastic case, and the fact that you can pick one of these up for just shy of $60 at the time of writing is nothing short of incredible. It's clean, has plenty of modern build features included, and it's just a pleasure to build in.

## 14 BOOTABLE WINDOWS

**NOW IT'S TIME** to get Windows installed. To do this, head to Google and search for "Windows Media Tool" on a separate system or laptop. Click the top result: "Download Windows 10 Disc Image (ISOFile) – Microsoft", which will take you to the official Microsoft website. You'll see a sub-heading called "Create Windows 10 installation media." Click "Download tool now."

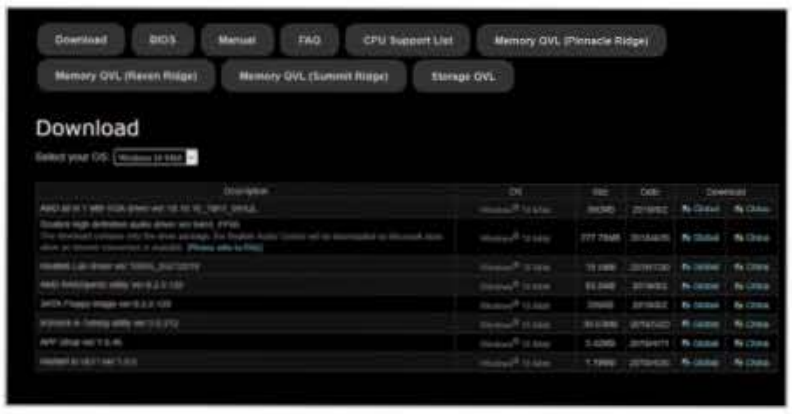
Once that's downloaded, run the program, and it'll identify which version of Windows you're using. Plug in an 8GB USB stick (preferably USB 3.0), accept the terms and conditions, then select "Create installation media (USB flash drive..." and hit "Next." In the next screen select your options. Making sure that your architecture is 64-bit, hit "Next" again, then choose USB flash drive, then hit next again, select the drive you've plugged in, and Windows will begin creating your bootable Windows install USB drive.



## 15 DRIVERS & BIOS

**NEXT, PICK UP** some key files for your system. On your other device, head to your motherboard's product page. Click "Support," and find your drivers. It's always better to get the brand-new ones from the website, and not rely on those found on the discs enclosed with the motherboard. Also, although some motherboards' Ethernet ports work without a driver download, some don't, so it's handy to have these.

Create a new folder on your USB stick and label it "BIOS," and another one called "Drivers." Make sure you download the AMD all-in-one driver/AM4 Chipset, your network driver, your audio driver, and then place them in "Drivers." As an aside, if your build has a dedicated GPU, you can also pick up your GPU drivers. After that, get the latest version of your BIOS—there should be a "BIOS" tab on the support page. Grab the file, then move it to your "BIOS" folder on the USB stick, and extract it on the drive before you go to your build.




## 16 UPDATING BIOS

**THIS PART CAN BE SCARY**. If you do mess it up, it's very hard to come back from without warrantying the board, and not all manufacturers accept liability for that (something ASRock states on its website). But as long as you don't suffer a major power outage or turn off the system, it's completely safe.

Plug the USB stick with the BIOS and Windows Installer into the back of your new system, and power it up. Mash the Delete key on startup to get into the BIOS. This part will vary depending on motherboard manufacturer, but you're looking for the same area and the same feature. In ASRock's case, select "Instant Flash" under the "Tool" section at the top of the BIOS page. Scan for your devices, find your USB stick, then the "BIOS" folder, and select the BIOS file you downloaded earlier. Hit "Update" and let the motherboard do its thing. It'll restart once or twice. Eventually you'll end up back in the BIOS screen with a freshly updated BIOS.

# BUDGET-BUSTING EXPECTATIONS

**AND THERE YOU HAVE IT,** one complete budget build for $535. So what was it like to build? Well honestly, not that difficult. A lot of budget builds are actually far less complex than you'd think. Realistically, there's a total of six separate parts that need installing in the case itself, and all of them are fairly plug-and-play. There's nothing very difficult, and it's a perfect opportunity for a first-time builder to stretch their legs into this hobby of ours.

Get down the line a bit, and fancy investing in a dedicated graphics card? You could easily throw in an AMD Radeon RX 570 or Nvidia GeForce GTX 1650 Super, both of which you can get for less than $160 at this point. It's worth noting that the Ryzen 5 3400G at the heart of this build (and in fact, all of AMD's APU processors) only comes with 8 PCIe 3.0 lane dedicated graphics, as opposed to the 16 you'll find on its non-integrated cousins. This is where Intel edges out a bit. Our recommendation for an Intel alternative is the Intel Core i3-8300. That's a quad-core part, minus the hyper-threading, but it comes with integrated graphics and 16 PCIe 3.0 lanes as standard for the GPU, which oddly (given the recent announcement of AMD only supporting Ryzen 3rd gen on its X570 series motherboards going forward), makes it the more attractive long-term choice.

As for performance, our budget-busting box did fairly well. Boot times were quick and sharp thanks to that M.2 PCIe SSD, although on the big file transfers the QLC NAND struggled a bit—it was pretty good with loading programs and transferring multiple sequential stuff, but with larger file transfers it struggled after a few minutes.

For everyday use it easily meets the mark. We also tested its graphical prowess, and at 1080p on Ultra it was capable of handling AAA titles, although not by any large measure. So if you're looking for some casual gaming on the side, the AMD Ryzen 5 3400G is king.

Ultimately, it's a sweet little box at a kick-ass price, and more than ideal for anyone that's just looking for a high-spec PC to build today for a low outlay.

### BENCHMARKS

| | ZERO-POINT | |
|---|---|---|
| Cinebench R15 Multi-Thread (Index) | 598 | 881 (47%) |
| CrystalDisk QD32 Sequential Read (MB/s) | 562 | 1,876 (233%) |
| CrystalDisk QD32 Sequential Write (MB/s) | 521 | 1,581 (203%) |
| Middle Earth: Shadow of War (fps) | 15 | 21 (40%) |
| Total War: Warhammer II (fps) | 10 | 15 (50%) |
| Assassin's Creed Odyssey (fps) | 9 | 13 (44%) |
| 3DMark: Fire Strike (Index) | 2,642 | 3,591 (36%) |

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point consists of an AMD Ryzen 3 3200G, 16GB (2x8GB) Corsair Vengeance LPX DDR4 @ 2666, and a 500GB Crucial MX500 SSD. Priced at $590. All game tests were performed at 1080p Ultra.

## 17 INSTALLING WINDOWS

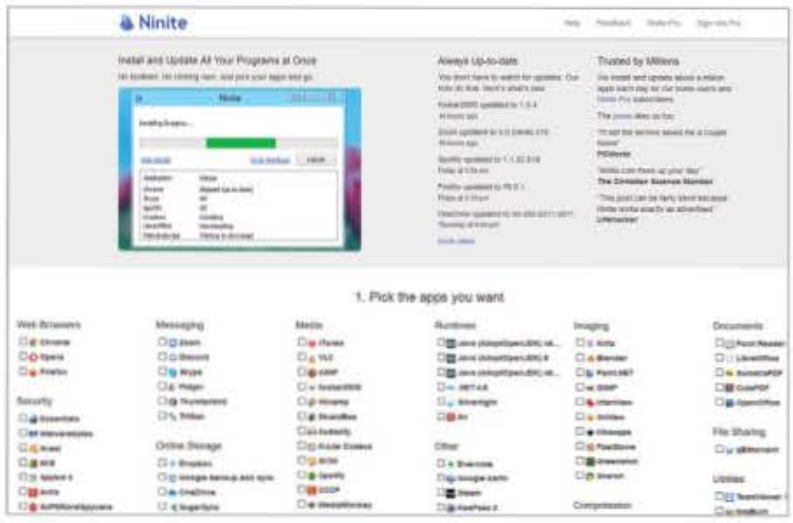
**NEXT, HEAD TO THE** "Boot" section of your BIOS, and reorder or boot from your USB stick—it should be labelled as "Windows 10 UEFI USB," or something similar. Move it to first in the queue, and hit F10 to save and exit. Your system will restart and then begin to run you through the installation process. Here select what language and keyboard layout you want to use, then after install it'll run you through which features you want to enable (we usually disable all ad tracking, Cortana, and full diagnostic options on every install).

If you've got an Ethernet cable plugged in and your port is working, it will also ask you to login to your Microsoft account or create one before letting you proceed. If you don't want to do that, just remove the Ethernet cable prior to the installation of Windows 10, and it'll let you create a local account and password. You can activate it or login later on the desktop if you want to.

## 18 THE POWER OF NINITE!

**USING NINITE** has become almost a ritual of ours whenever configuring and setting up a new system. Once you're on the desktop and your drivers are installed, use an internet browser to reach https://ninite.com. From there you can download the latest versions of a bevy of programs, including web browsers, security essentials, messaging applications, media centers, imaging tools—you name it.

Select what programs you want to download and install, and then hit the "Get Your Ninite" button at the bottom of the page. Run the installer, and Ninite will download and install all of the programs you requested, but without having to search the internet for them or being attacked by unwanted adware in the process.



1 **One of the nicer touches to the ASRock B450M-HDV board is the fact that the M.2 slot is situated above the PCIe 3.0 slot, meaning it won't get hot from a graphics card sitting directly above it.**

2 **If you do intend to go with a dedicated GPU later on, bear in mind performance will be worse, since AMD's APU series processors only support 8 PCIe 3.0 graphics lanes, as opposed to the 16 you'll find elsewhere.**

3 **The first thing we'd do if we were to run this long term would be to install some more fans. Investing in two premium 120mm fans for the front and then moving that included one back to the rear would work a treat.**

4 **If you dropped down to 8GB and a smaller SSD with Intel you could likely pick up an AMD Radeon RX 570 to act as a dedicated GPU if you wanted to.**

# LOCK IT DOWN

**Nick Peers** reveals how to make your PC secure against malware and other threats

**KEEPING YOUR PC** safe from malware is a never-ending challenge. With new threats popping up (and then fading into the background again) all the time, we're indebted to security experts such as Kaspersky, Norton, and Bitdefender for their constant vigilance. Their security tools are constantly evolving to keep up with the changing malware landscape, but however hard they work, you can't rely on them 100 percent to keep your PC protected.

Cybercriminals are increasingly preying on us directly to try and trick their way onto our machines and into our wallets. These days, you're as likely to be the architect of your own downfall by responding to a scam alert as you are to be infected by other means. But that doesn't mean that you're fighting a losing battle.

In this feature we're going to reveal what types of threat are currently the most dangerous, and what you can do to ensure you remain safe from them. We'll reveal what the latest threats are, from hack tools to adware, and help you strengthen your network's security to keep you protected.

# THE PHANTOM MENACE

## Keep adware away from your computer

**THE WORLD OF MALWARE** is constantly evolving—who'd heard of social engineering, ransomware, or cryptomining until recently? In its State of Malware 2020 report, Malwarebytes noted some interesting trends. One was that malware is increasingly focusing on business rather than consumers, as criminals spy bigger opportunities.

That said, don't ditch all your anti-virus software just yet—consumer infections were only down two percent on the previous year. Of more significance is the changing landscape. The biggest source of infections is adware—programs that don't carry malware, but try to trick people into downloading malware or giving up personal details.

The biggest jump in the list is by so-called "hack tools," which is again often a legitimate type of program that provides hackers with a way into networks (see pages 41-42). The growth in popularity of both adware and hack tools suggests that security software's ability to spot and detect more traditional forms of malware is pushing cybercriminals to shift their focus toward weaker spots in your defences.

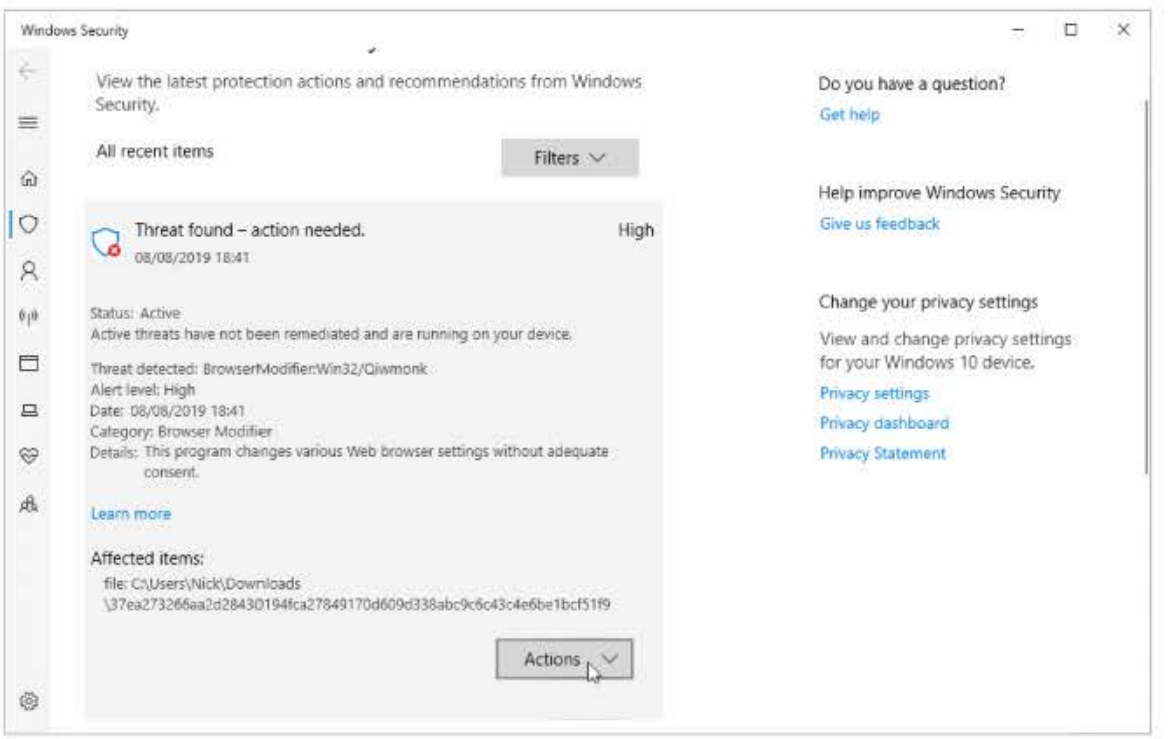
Not all newer threats stay the course: Cryptomining, whereby malware allowed criminals to hijack a computer's processing power to help them mine for Bitcoin and other digital currency, has fallen in popularity. But even here, new variants continue to emerge alongside existing ones, while traditional forms of infection, from worms to Trojans, spyware to back doors, remain a persistent threat.

### STAY SAFE

You may think that now's a good time to let your security software subscription lapse and revert to free protection. While it's true that Microsoft Security—built on the back of Windows Defender—is scoring highly in independent malware tests (it's currently listed as a top product on www.av-test.org with more established rivals), it lacks tools to help protect against wider threats. Paid-for solutions, like Norton (https://norton.com), Bitdefender (www.bitdefender.com), and Kaspersky (www.kaspersky.com) offer a more comprehensive set of tools to protect against a wider range of threats.

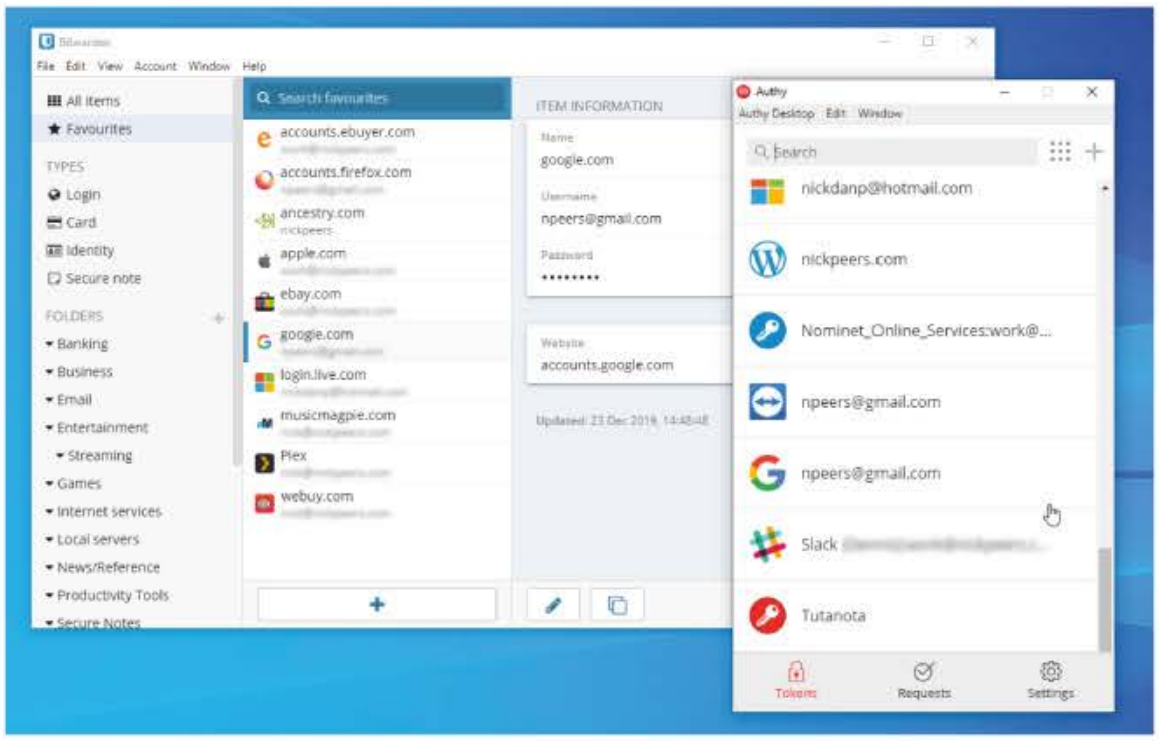
A big hole in Windows's security is its built-in firewall. Windows Firewall can provide comprehensive protection, but by default it only monitors inbound traffic from other networked devices and the internet to your computer. Connections originating from your PC, such as installed software (including software you may have been tricked into installing)—are ignored.

The solution is to install a dedicated firewall with two-way protection—a feature in all paid-for products and the free standalone Comodo Firewall (https://personalfirewall.comodo.com/)—or add two-way protection to Windows Firewall.




© DELL, MICROSOFT

**Windows Security offers a good first line against attacks, but it still needs additional help.**




**We're huge fans of a multi-layered approach to online accounts – strong passwords and 2FA.**

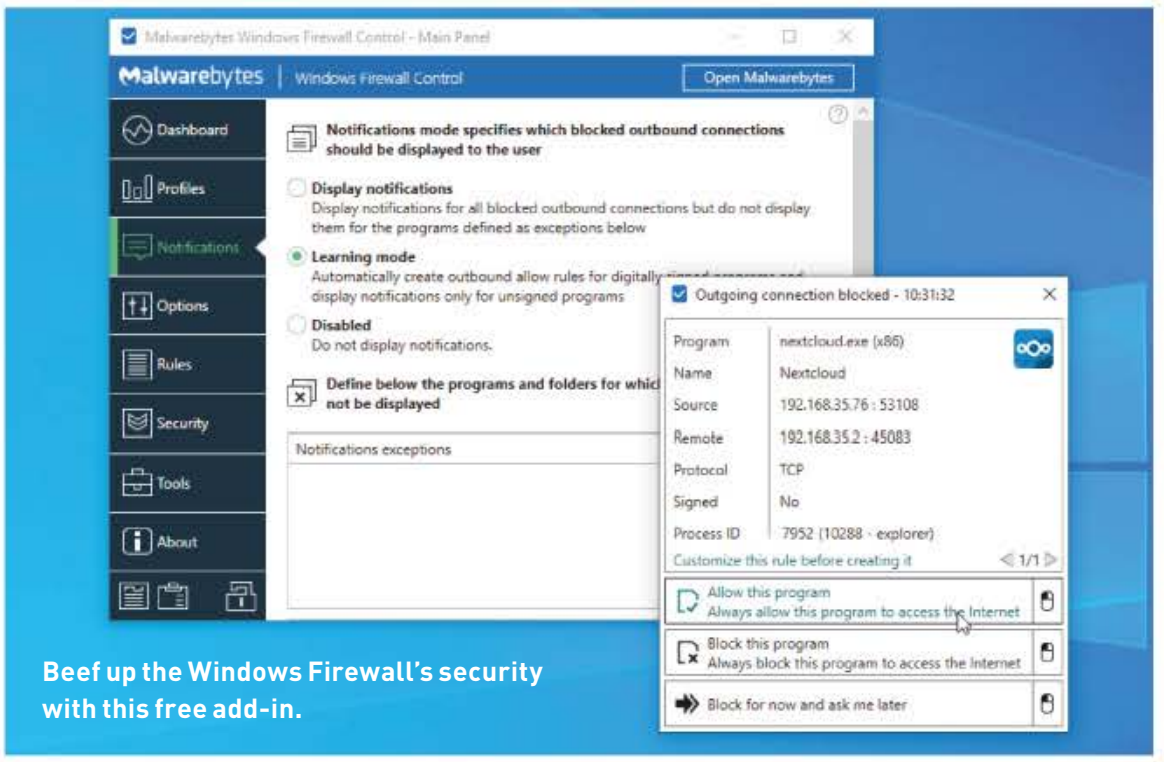
of online life. Now is the time to tighten the security of your online footprint by using a password manager (we recommend Bitwarden—www.bitwarden.com) and two-factor authentication (manage codes with Authy—https://authy.com) to lock down your online accounts. Take the time to generate new, lengthy (14 characters should be sufficient) and random passwords for your core online accounts, and switch on 2FA where possible.

Also consider a VPN, particularly when connecting through unsecure wireless networks. This scrambles your connection so that data transmitted can't be intercepted. Try Windscribe (https://windscribe.com), which has a generous free package offering 10GB per month.

Finally, help ensure all your software stays updated with Patch My PC (https://patchmypc.com/home-updater-overview).

By installing Windows Firewall Control (www.binisoft.org/wfc) you can create rules for outgoing traffic to prevent apps and processes from accessing the internet.

WFC is set to allow all outbound traffic by default—to filter it, launch the program, switch to the "Profiles" section and select "Medium filtering (recommended)". Check the failsafe "Automatically set" box. Switch to "Notifications" and select "Learning mode" to switch monitoring on. All digitally signed and trusted apps will be given network access automatically, but you'll start to see pop-up notifications for other apps. If they're trusted, click "Allow this program;" if you're not sure, select "Block for now and ask me later."

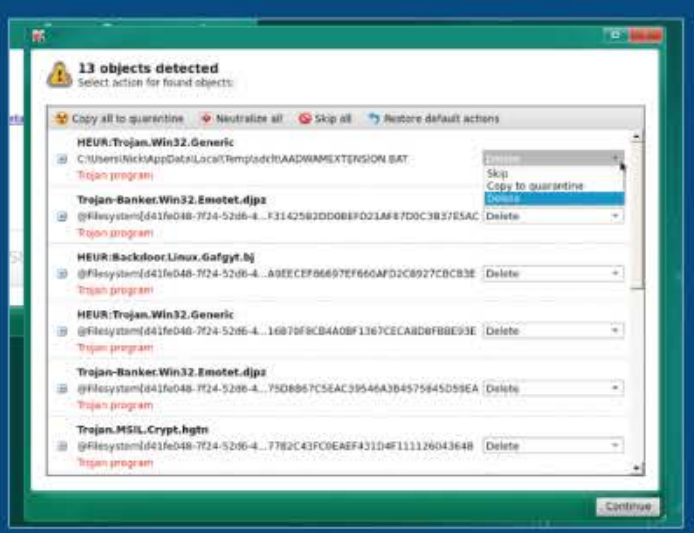



**Beef up the Windows Firewall's security with this free add-in.**

## GO FURTHER

It's not just malware you need to be concerned about, but all aspects

## REMOVING STUBBORN INFECTIONS




**In most cases your security software should stop infections, but if some creep through you may find them difficult to remove. Start by attempting to boot into Safe mode with networking—doing so usually cripples the malware enough to enable your security software to download the latest updates, perform a successful scan, and remove the malware. The quickest way to do this is to type "msconfig" into the search box and click "System Configuration." Assuming you've not been locked out by the malware, switch to the "Boot" tab to tick "Safe boot" and select "Network," before clicking "OK" and rebooting.**

**If this doesn't work, visit your security vendor's home page on a clean machine to create a rescue disc. Failing that, use Kaspersky's tool (https://support.kaspersky.com/viruses/rescuedisk), which is free for all. Boot from this, bypassing Windows entirely, and you should have all the tools to defeat infections.**

**After removing any infection, perform multiple scans to verify all traces of it have gone—both before and after rebooting back into normal Windows.**

© KASPERSKY.COM, XFINITY

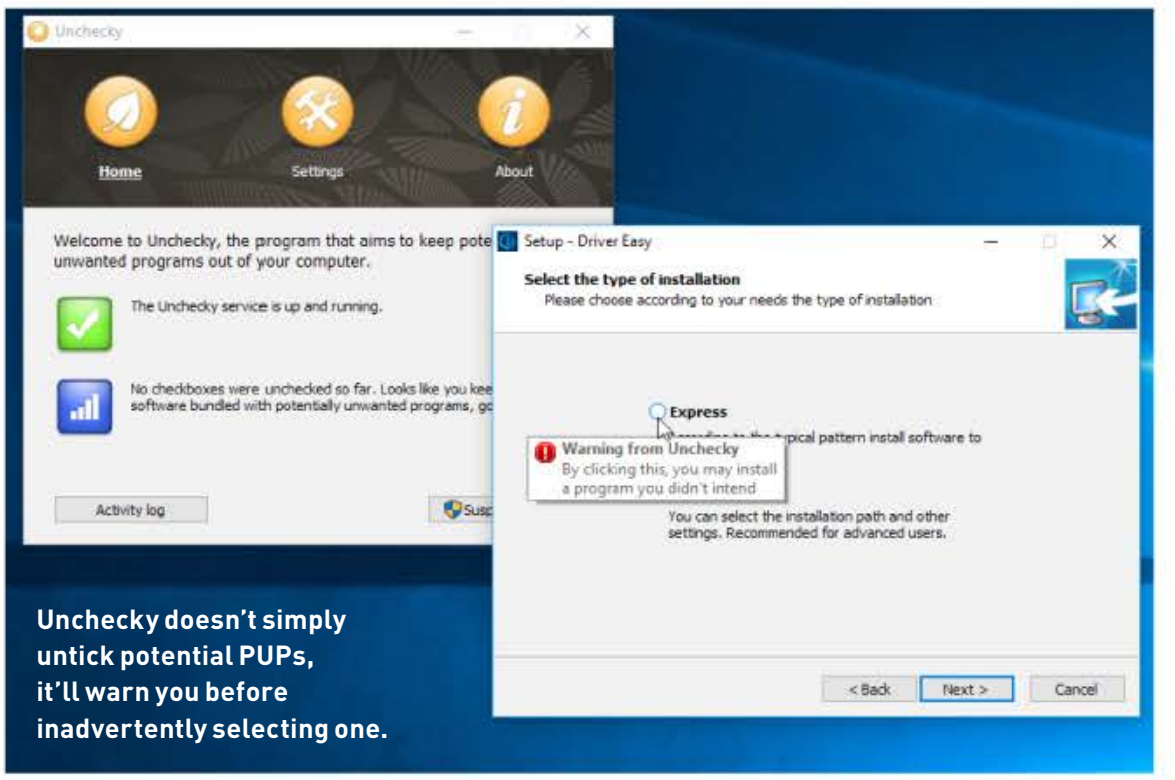
# ATTACK OF THE PUPS

## Keep bundleware off your PC with our guide to unwanted programs

**AS REPORTED ON** the previous page, the biggest individual threat to consumers comes from adware. In the past, adware meant ad-supported software, but later it evolved to include so-called PUPs (potentially unwanted programs), which are offered alongside the original program during installation. Sometimes these unsolicited extras are easy to avoid, but some use deliberately misleading language and confusing options to trick you into installing them.

PUPs, better known as bundleware, are usually more annoying than outright malicious. Most are ignored by your security software, so you'll need additional help: Unchecky (www.unchecky.com) offers limited free protection, but Malwarebytes Premium (www.malwarebytes.com) is by far the best at blocking these.

Most PUPs should be removable via "Settings → Apps → Apps & Features," but third-party apps make them easier to spot. IObit Uninstaller (www.iobit.com/advanceduninstaller.php) has a dedicated bundleware section, though it ironically offers bundleware in its own setup process (IObit's free Advanced SystemCare Free tool).


Unchecky
Home
Settings
About
Welcome to Unchecky, the program that aims to keep pote
unwanted programs out of your computer.
The Unchecky service is up and running.
No checkboxes were unchecked so far. Looks like you kee
software bundled with potentially unwanted programs, go
Activity log
Setup - Driver Easy
Select the type of installation
Please choose according to your needs the type of installation
Express
Warning from Unchecky
By clicking this, you may install
a program you didn't intend
You can select the installation path and other
settings. Recommended for advanced users.
< Back
Next >
Cancel

**Unchecky doesn't simply untick potential PUPs, it'll warn you before inadvertently selecting one.**

### SOCIAL ENGINEERING SCAMS

Adware as a threat has shifted away from being merely annoying and is now considered dangerous once again. That's because it's often used to identify software used by scammers to try and hack people's computers through social engineering.

Scammers directly contact users through legitimate channels—including by phone, text message, social media, and email—to try and trick them into handing over sensitive personal details, such as bank account information. This may be attempted directly through tricking the victim into volunteering the information themselves, or it may be an indirect attempt. Examples of the latter include the well-known tech-support scam. This can originate in a phone call or via fake error messages on a website that pop up as you're innocently browsing away, asking you to call a number. In both cases, you may be asked to provide payment before fixes can be applied, or directed to download and install software that will allow the scammer to take control of your computer, ostensibly to fix the problem, but more likely to lower your defences and install more malware onto your system.

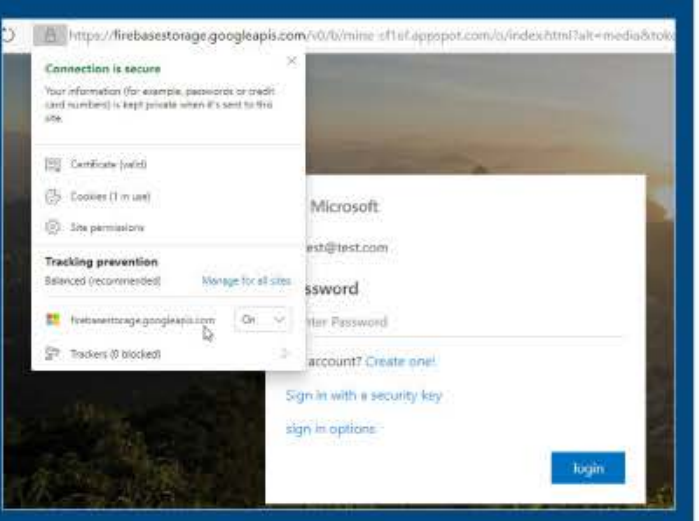
In all cases, social engineering scams are designed to unsettle you and then—while you're off-balance—trap and ultimately defraud you. We recommend you take the time to visit www.usa.gov/online-safety and work your way through the useful tips to get sound guidance on how to avoid being caught out.

## PROTECT YOURSELF FROM WEB SKIMMING

**Many websites that sell products or services rely on third-party payment providers. When you make a purchase, you're redirected to that provider's website to complete the transaction, before being redirected back.**

**Scammers have ways of intercepting traffic to these sites to pop up their own fake version of the payment site to trick users into giving up their card details. This form of "man-in-the-middle" attack doesn't target the payment provider, but instead alters the code on the merchant website to redirect your traffic to the phishing site.**

**Malwarebytes Premium's web protection offers real-time protection against known phishing sites based on their behavior, but you can take further steps: Verify the payment provider's website using the information in the browser address bar. Click the padlock to view the site's security and verify it's pointing to the site you expect (make sure it's https://provider.com and not something like https://http.ps//provider.com). If in doubt, cancel the transaction and alert the online merchant.**




*Beware facsimiles of legitimate websites—check the address before passing on your personal details.*

© MICROSOFT, MALWAREBYTES

## STRENGTHEN PROTECTION

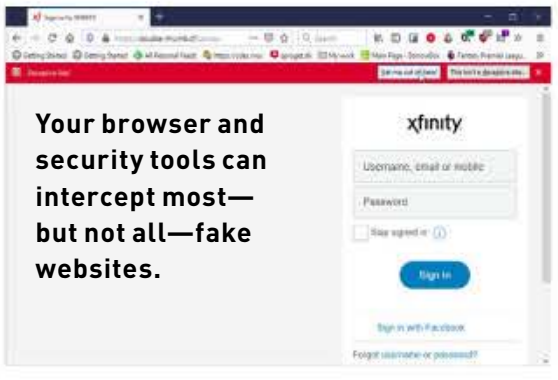
Many scams originate on the web. These type of social engineering scams are part of the wider malvertising—or malicious advertising—family of malware. These are advertisements that can appear on any webpage, and may contain malicious code or, more commonly, rely on trickery to trigger the scam. Those who fall for it are then redirected to the scammer's landing page.

While many fake websites are quickly reported by sites like Phishtank (www.phishtank.com), which in turn leads to them being blocked by your web browser's own security tools, you should go further to proactively block these from getting a foothold in the first place. Review the security options in your browser (such as "Privacy and Security" in Chrome), and install uBlock from your browser's add-ins page (Chrome Web Store, for example).

Also check to see if your security software offers additional protections against web-based threats – free products may offer limited protection, but paid-for products will usually extend this further, and that includes the paid-for Premium version of Malwarebytes Anti-Malware.

The free version of Malwarebytes works as a scan-and-removal tool—there's no active protection against keeping threats off your PC in the first place. The Premium version offers four real-time components—malware, exploit, web, and ransomware—and is more aggressive than other tools when it comes to adware and so-called riskware. This means that on occasion you may have cause to disagree with its findings.

Start by researching the threat—click the link in "Quarantine" to get a detailed report from Malwarebytes's own website, then look further afield (https://forums.malwarebytes.com/ is a good place to start) for other people's opinions. If you decide the tool is safe, open Malwarebytes and click "Detection History" to access "Quarantine." First, restore the file by selecting it from the list and clicking "Restore," then switch to the "Allow List" tab and click "Add" to select the program file to exclude it from future scans.




**Your browser and security tools can intercept most—but not all—fake websites.**

# PREVENT DRIVE-BY HACKING

## Keep hackers out of your home network and away from all your devices, not just your PC

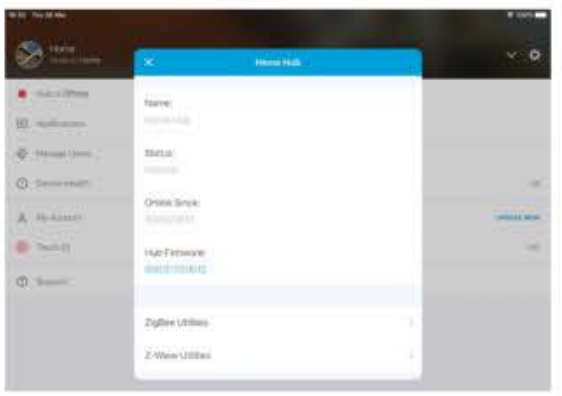
**ANOTHER GROWING THREAT** to your computer and wider network comes from so-called hack tools. These are part of a wider range of tools known as "riskware', which are tools that aren't in themselves malicious but are capable of being used for nefarious ends by hackers. This is a gray area usually ignored by security software because the targets are perfectly legitimate programs that perform useful functionality—for example, Nirsoft's ProduKey is designed to help you recover Windows and Office product keys from your computer, but because it can also be deployed to pull product keys from other computers on your network it's designated a hack tool by Malwarebytes Anti-Malware.

Other types of tool that fall into this category are network scanners, SSH, and even tools designed to perform illegal activities such as GameHack, a family of tools that bypass gaming platform server restrictions or paywalls.

If you want protection against these threats then, as with adware, then Malwarebytes Anti-Malware (www.malwarebytes.com) is a must-have.

## NETWORK THREATS

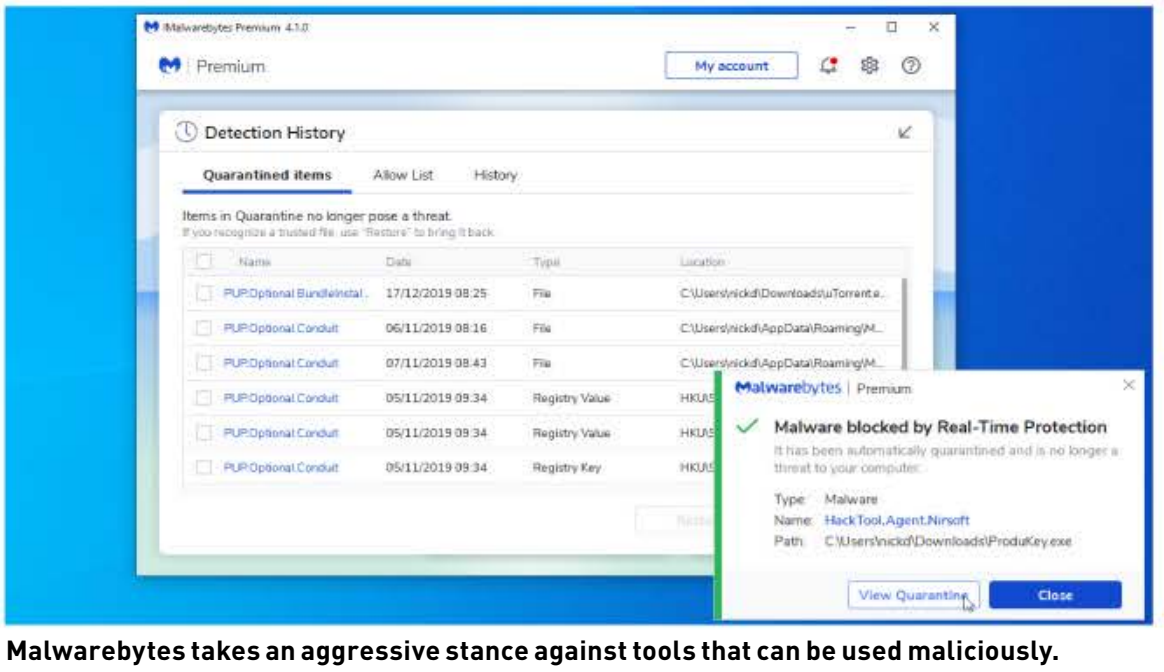
Many of these appropriated tools, along with tools developed specifically for cybercriminals, are used to attempt drive-by hackings of computers and their networks. The tools are usually indiscriminate—scanning thousands of public IP addresses in the hunt for weak spots that give hackers access to home and business networks, giving them carte blanche to do what they will.



**SmartThings hubs update their own firmware—the hub goes offline for the duration.**

You can reduce your risk of attack by following the step-by-step guide opposite. It involves strengthening the device that provides a gateway to and from the internet: your router. These are often shipped with gaping security holes, so follow the advice across the page to instantly improve matters, and also increase protection against anyone within physical range of your network (including any neighbors piggybacking on your internet connection).

Another weak point is the devices on your network. Their connections to the internet are "guaranteed" in that they're trusted, but they also make it possible to




**Malwarebytes takes an aggressive stance against tools that can be used maliciously.**

© XFINITY, SMARTTHINGS, MALWAREBYTES

target your network through a specific device rather than a generic attack through your gateway. Your PCs (and Macs if you have them) should already be protected with strong security software, but you'll need anti-virus for your Android mobile too. Apple devices are more tightly locked down, but here it's important to install the latest updates, avoid insecure wireless networks, and exercise the same caution opening emails and visiting websites as you would with your PC.

## IoT VULNERABILITIES

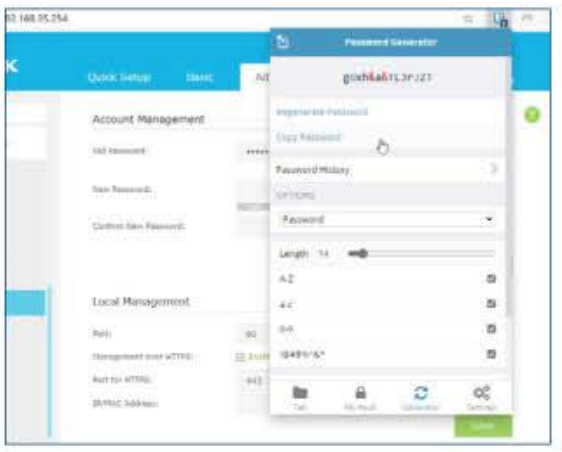
The growth of the Internet of Things—smart devices spanning from speakers to energy meters, security cameras to lights—poses its own threat. The IoT is often overlooked when performing security audits, but it's particularly vulnerable to attack. Sadly, security is often of secondary importance to IoT manufacturers—the devices have limited storage or lack mechanisms for firmware updates to close vulnerabilities.

If you've not yet done so, take the time to identify all these devices and perform a security audit on them. More reputable devices—such as Samsung's SmartThings hub and Amazon's Alexa range of speakers—should be constantly on the lookout for firmware updates, and alert you via whichever connected apps you have installed.

Other devices, however, may not have this ability, relying on you to hunt down and apply firmware updates yourself (this is true of your router too). Visit the device manufacturer's webpage and look in the support or downloads section for possible updates. If none exist, try Googling the product name and keywords like "vulnerability" or "hack" to see if attacks have occurred.

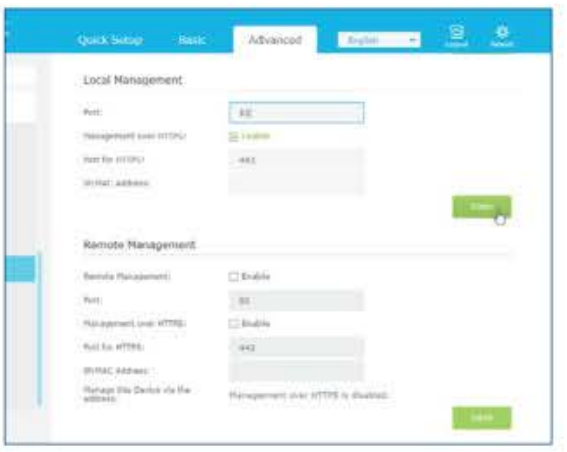
If devices are no longer supported, consider up-to-date replacements. Failing that, follow the advice in the step-by-step to place them on their own isolated guest network, away from your computer and other importance devices—you may wish to do this with all your IoT equipment. You should still be able to access them, but the connection will be made over the internet rather than through your local network.

## LOCK DOWN YOUR NETWORK



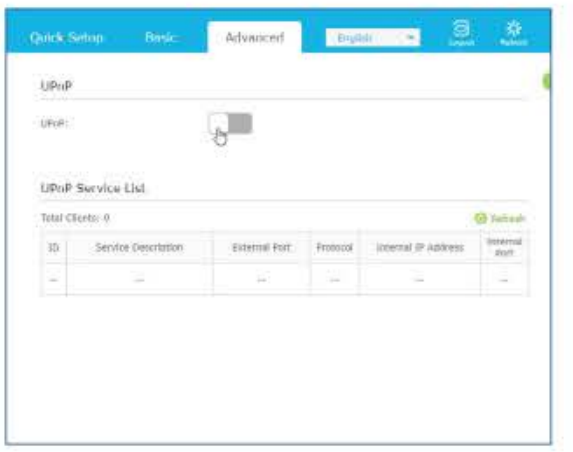

### 1 LOCK DOWN ROUTER

Open your browser and log into your router's configuration utility via its IP address. If you've not yet done so, look for an administration section where you can change the password (choose a strong one using password manager) and disable remote administration.




### 2 FORCE SECURE ACCESS

If the option exists, tick the box to access the router over a secure (HTTPS) connection. If you run into problems—our TP-Link doesn't support the TLS connections required in Firefox, for example—change the port for non-secure remote management from the default (80).

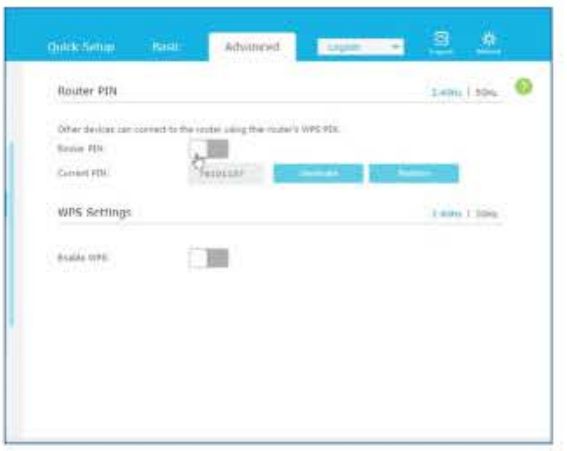



### 3 DISABLE UNSAFE SERVICES

You'll need to hunt around for these options, but disable UPnP (use manual port-forwarding instead), followed by these services if you can locate them: Ping, Telnet, SSH, and HNAP—all allow remote access. Consult the router manual for guidance if needed.

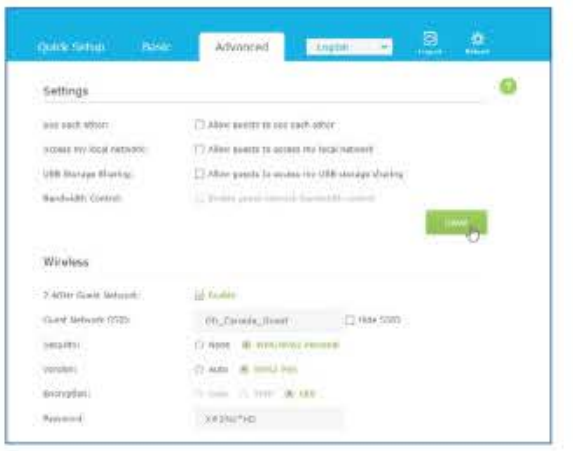
### 4 LOCK DOWN WI-FI

Change your Wi-Fi network names if they list the router manufacturer or model. Make sure they're protected by strong WPA2 encryption and a lengthy password. Set a wireless schedule so the network is switched off and unavailable while you sleep or are away from home.




### 5 MORE LOCK-DOWN TIPS

Reposition your router to the center of your house or reduce the transmit power to prevent your Wi-Fi signal spilling out into neighboring areas. Locate the WPS section and make sure devices can't connect to your router using a PIN. Try disabling WPS when not needed.




### 6 SET UP ISOLATED GUEST NETWORK

Switch on the guest network, which you can use to give other people and untrusted devices like IoT gadgets access to the internet. Make sure guests can't see or access your local network to ensure any compromised devices can't be used to gain access to it.

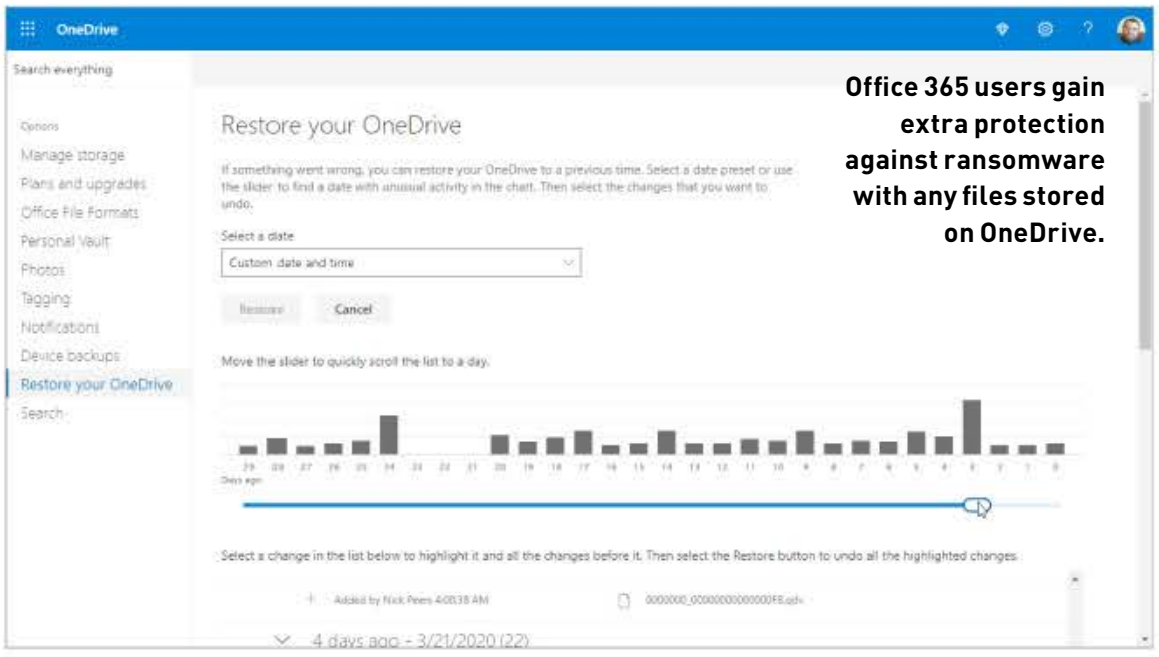
© TP LINK

# DEAL WITH RANSOMWARE

## Locked out of your files? We have the tools to get your data back

**RANSOMWARE MAY NOT** be the threat it once was—these days, businesses are more frequently targeted than consumers—but that's not to say you're immune. If you need reminding, ransomware is a form of malware that encrypts all or part of your drive before hackers demand a ransom to provide you with the decryption key required to get it back again.

Most forms of ransomware target your data rather than locking you out of your entire PC. For those that do, check your security software's website for a rescue disc. Ransomware that targets your files is trickier to remove: typically you'll need to use a rescue disc or boot into Safe mode with networking to remove the underlying infection before you can look at recovering your files.


OneDrive
Search everything
Restore your OneDrive
Manage storage
Plans and upgrades
Office File Formats
Personal Vault
Photos
Tagging
Notifications
Device backups
Restore your OneDrive
Search
Select a date
Custom date and time
Cancel
Move the slider to quickly scroll the list to a day.
Select a change in the list below to highlight it and all the changes before it. Then select the Restore button to undo all the highlighted changes.
4 days ago - 3/21/2020 (22)

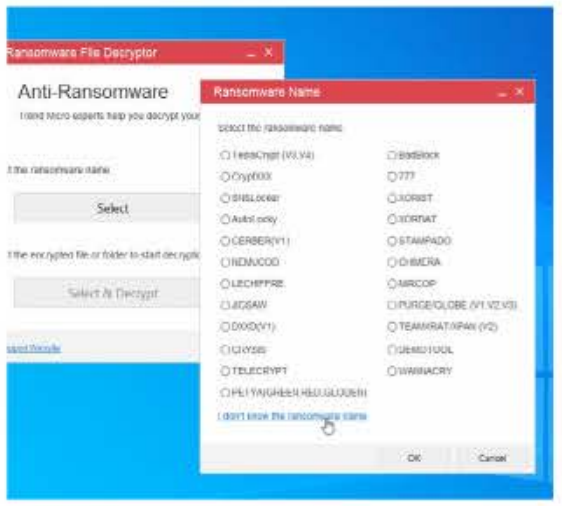
**Office 365 users gain extra protection against ransomware with any files stored on OneDrive.**

### RECOVER ENCRYPTED FILES

If you have a recent backup, you'll hopefully find your unencrypted files are all safely housed here, ready for you to restore. You may lose some recent work, but that's all. That said, if your backup location is within reach of the ransomware, it may have been breached too. This is particularly true of network drives where you've saved the network credentials in Windows itself.

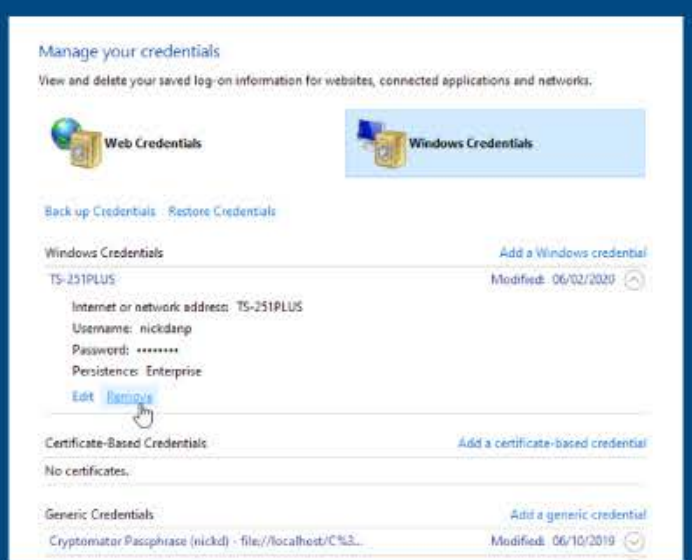
If your data is synced to the cloud, then it's likely the encrypted files have been uploaded, but if you're lucky your cloud provider should have file versioning enabled, allowing you to attempt to roll back to the last unencrypted backup. Instructions vary depending on your cloud provider, but taking OneDrive as an example, log into your account at https://onedrive.live.com/ and navigate to each file you want to restore. Select it and click "Version history" to access all available versions, preview (where supported) and download an older version.

Sadly, you'll have to do this for each individual file you need to recover if you're relying on free storage, but if you have an Office 365 subscription you should receive a warning that lots of files have been changed or deleted and given the




**Trend's Ransomware Decryptor Tool can recover data following an infection.**

## PROTECT YOUR NETWORK SHARES




*Delete any stored network usernames and passwords to protect your network drives from ransomware.*

**Any network drive easily accessible from Windows is vulnerable to ransomware. Tightening security means changing your network shared credentials. First, if you've set up a user on your NAS that shares the same username and password as your Windows account for ease of access, log into your NAS's user account settings and change the password to something unique.**

**Also, make sure you're not saving network credentials: When you're next prompted to log on to a network share, make sure the box "Remember my credentials" is left unticked. If—as is likely—you've previously saved credentials, type "credentials" into the search box and click "Credential Manager." You should see entries for each saved network password under "Windows Credentials." Click the downward arrow button followed by "Remove → Yes."**

**If you're accessing the network share through a third-party app—say your backup tool—you should be able to store your credentials in the app itself, beyond the ransomware's reach. In Macrium, select "Other Tasks → Edit Defaults → Network."**

© MICROSOFT

opportunity to roll back to earlier, pre-infected versions. If the feature doesn't appear automatically, click the OneDrive settings button and choose "Options," then select "Restore your OneDrive." After verifying your identity, you'll be able to quickly roll back a set amount of time from the drop-down menu, or choose "Custom date and time" to review changes on a timeline and pinpoint the best moment to roll back to.

If you've no backup, or you're looking for a quicker fix, then you'll need to see if there's a decryption tool for the specific ransomware infection. Your security tool has hopefully identified the ransomware type, so visit www.nomoreransom.org/en/decryption-tools.html for a comprehensive list of types, tools from reputable antivirus vendors, and a guide to using them.

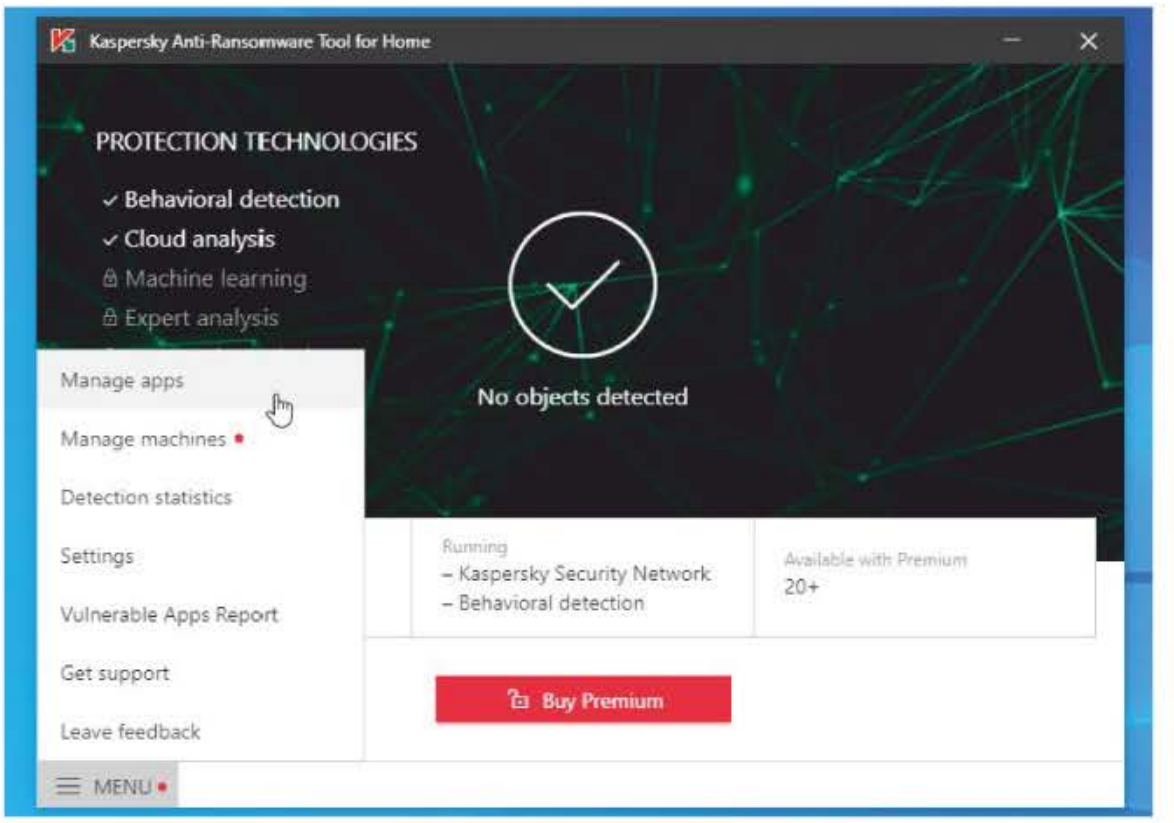
Be careful that you've got the right tool, otherwise you risk scrambling the files beyond any attempt at recovery—thankfully, some vendors like Trend Micro's Ransomware File Decryptor tool combine all its known ransomware decryption tools inside a single program. Although you're asked to select the ransomware type, there's a handy "I don't know the ransomware name" link—click this and you'll be prompted to select one of your infected files. The app will then analyze it to reveal what ransomware is behind it (and more importantly help you restore your files).

## PROACTIVE PROTECTION

Check to see if your current security tool offers protection against ransomware. Most free tools, including Microsoft Security, have measures to block known ransomware, but if you want to go further and take proactive measures, you'll need third-party software.

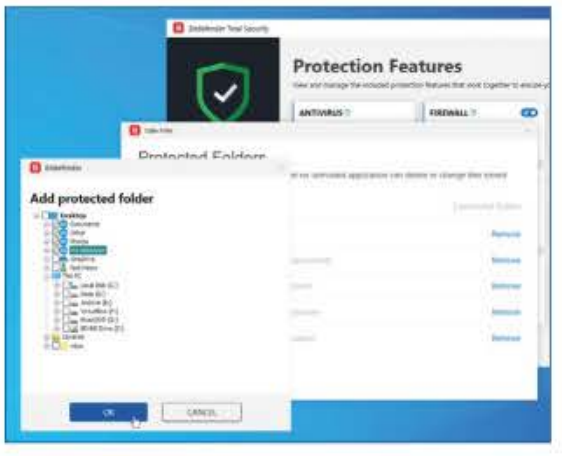
Most paid-for apps offer additional protections—for example, Bitdefender 2020 (www.bitdefender.com) offers several tools, including a Ransomware Remediation tool that's designed to block ransomware by first blocking applications exhibiting suspicious behavior, before backing up targeted files before they can be encrypted; these are then restored if necessary. Bitdefender also offers a related tool called Safe Files. To see how it works to block unknown applications from accessing (and potentially encrypting) your files, check out the step-by-step guide below.

If your budget is tight, then free add-on protection is available too. Kaspersky Free Anti-Ransomware (www.kaspersky.com/anti-ransomware-tool) monitors for suspicious activity that might be symptomatic of a ransomware attack, blocking suspicious apps until you can review them (trusted apps can then be whitelisted via "Manage Apps" on the main menu). It'll also protect network shares if it detects a remote machine's attempt to encrypt its contents. You can safely install it alongside other anti-malware tools.



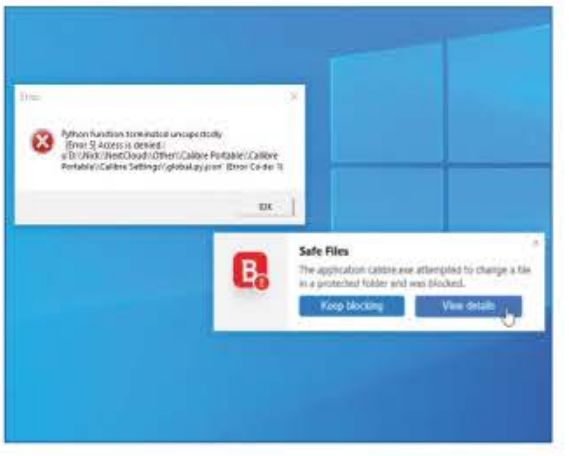

**Kaspersky Anti-Ransomware monitors and blocks suspicious apps until they can be reviewed.**

## PROTECT VULNERABLE FOLDERS WITH BITDEFENDER



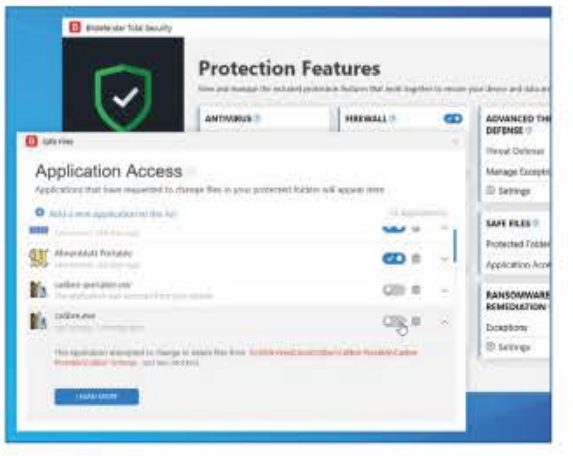

### 1 PROTECTED FOLDERS

Open the main Bitdefender program and select "Protection" from the left-hand pane. Verify "Safe Files" is switched on, then click "Protected Folders." Click "Protect More Folders" then tick the folder(s) you want to protect from unauthorised access. Click "OK."




### 2 WHITELIST APPS

Bitdefender allows certain trusted programs like Microsoft Office access to your folders but will automatically block unknown apps. You may see an error message attempting to launch or use the program, then a Safe Files dialogue pops up.




### 3 TRUSTED APPS

Click "View details" to investigate the app in question—its name and file path will be listed, helping you identify if it's safe or not. Assuming it is, flick the switch to "on." You can also manually add trusted apps via the "Add a new application to the list" link.

© KASPERSKY, BITDEFENDER

# TECH PORN

## 1 SOUND ON

Sound cards truly are a thing of the past. The Z490 Aorus Pro AX comes equipped with hi-res audio support, with a shiny new HD audio codec that includes a Smart Headphone Amp for automatically detecting the impedance of your headset or earphones. This helps to eliminate distortion and ensures that high-frequency audio comes across perfectly clear.

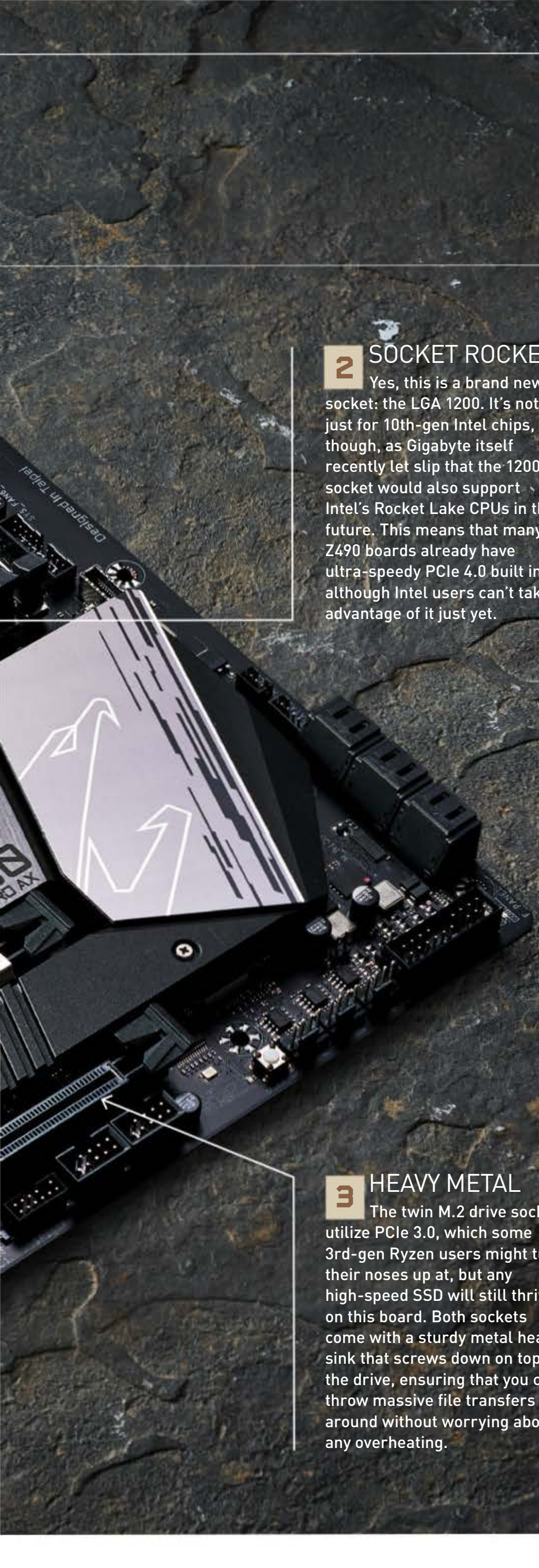
# Gigabyte Z490 Aorus Pro AX

**THE Z490 INTEL CHIPSET** is finally here, supporting the new 10th-generation Intel Core i9 through to i3 processors. These are the Comet Lake-S chips, boasting improved performance and hyperthreading in every chip, and at better value per core than previous generational pricing. Of course, we needed a new chipset—Intel's answer to the high-end X570 boards AMD has been pushing. The Z490 chipset brings a bunch of changes, most notably a new CPU socket. It signifies a big step forward for Intel, as the new socket will support future Intel chips.

This is a big shift and might annoy some Intel users looking to upgrade their systems, but there are plenty of more subtle improvements too. Maximum memory speed support is up, from DDR4 2666 to 2993. Some high-end features from previous mobos are more common now, such as Wi-Fi 6 support and 2.5Gb Ethernet.

The Z490 Aorus Pro AX from Gigabyte has all the bells and whistles the new chipset brings, and then some. Dual USB-C support, high-quality Realtek audio, and up to 128GB of system memory capacity makes for a powerful centerpiece to any system.

Thermal design is a key focus too, with numerous dedicated component heat sinks and temperature sensors. The heat sink fins are no longer flat; a textured design with holes to route warm air ensures that heat is dissipated faster, while an extra-large 8mm heat pipe at the top edge of the board keeps the MOSFETs from overheating. It's a very polished product—with only a little tasteful RGB lighting, thankfully. –**CHRISTIAN GUYTON**



### 2 SOCKET ROCKET

Yes, this is a brand new socket: the LGA 1200. It's not just for 10th-gen Intel chips, though, as Gigabyte itself recently let slip that the 1200 socket would also support Intel's Rocket Lake CPUs in the future. This means that many Z490 boards already have ultra-speedy PCIe 4.0 built in, although Intel users can't take advantage of it just yet.

### 3 HEAVY METAL

The twin M.2 drive sockets utilize PCIe 3.0, which some 3rd-gen Ryzen users might turn their noses up at, but any high-speed SSD will still thrive on this board. Both sockets come with a sturdy metal heat sink that screws down on top of the drive, ensuring that you can throw massive file transfers around without worrying about any overheating.

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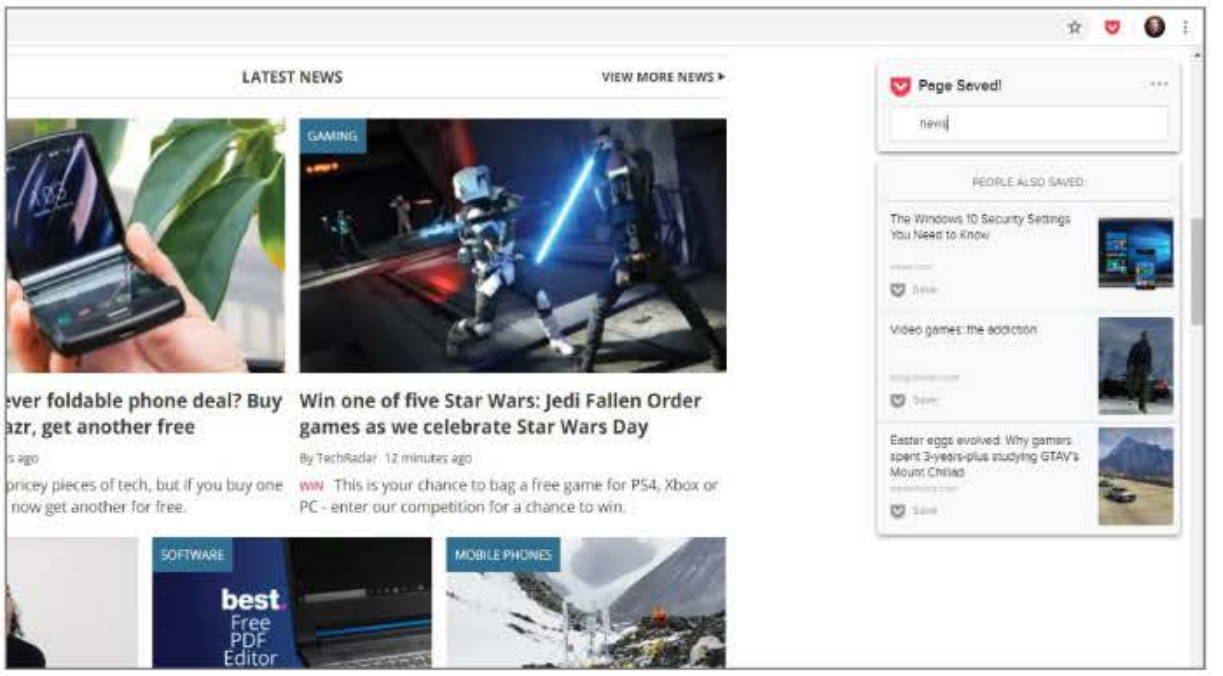
# HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

## TIP OF THE MONTH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Easter eggs evolved: Why gamers spent 3-years-plus studying GTAV's Mount Chiliad

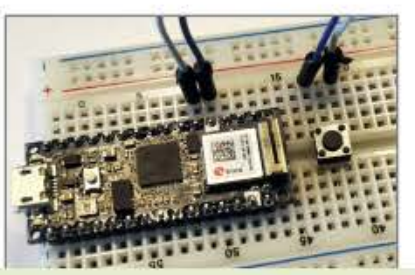
### CREATE A BETTER READING LIST WITH SAVE TO POCKET

Another useful Chrome extension, Pocket (also known as Save to Pocket) is a tool that lets you quickly capture webpages and articles online for later reading. Pocket functions across devices, so you can save a news story on your desktop browser and then read it on your phone later. Pocket also provides reading recommendations based on the content you save!

## MAKE – USE – CREATE

**54**
Benchmark your GPU like Maximum PC

**58**
Message friends securely using Retroshare



**64**
Get started with Arduino in two simple projects

© POCKET, MSI

CHRISTIAN GUYTON
STAFF WRITER

## HANDHELD HEAVEN

We've got a classic Nintendo teardown this issue; something that coincided with this writer's decision to buy my partner a Switch Lite. Compared to my full-fat Switch, the Lite is a truly compact unit, with a tiny but bright 720p LCD display. It's clear that Nintendo is (as ever) leading the charge in portable gaming.

It got me thinking about handheld gaming, and how PC gaming has remained almost entirely absent from that sphere. Sure, we now have gaming laptops that can rival home consoles, but genuine handheld PC platforms are virtually non-existent beyond streaming through smartphones. In fact, smartphones are becoming the dominant platform for pocket-friendly gaming. Sony abandoned its efforts after the lackluster PSP Go, and while Switch Lite sales have been strong, they're not close to the 150+ million Nintendo DS units sold prior to the Switch.

Modern Android and Apple phones are competent gaming platforms, with some designed specifically with gaming in mind, such as Asus's ROG Phone. But if you haven't already, check out the Alienware Concept UFO. That's what I want the future of handheld gaming to look like: PC-powered, customizable, with access to PC's gloriously huge game library.

↘ submit your How To project idea to: comments@maximumpc.com

IFIXIT presents:

# AUTOPSY

THIS MONTH WE DISSECT...

## About iFixit

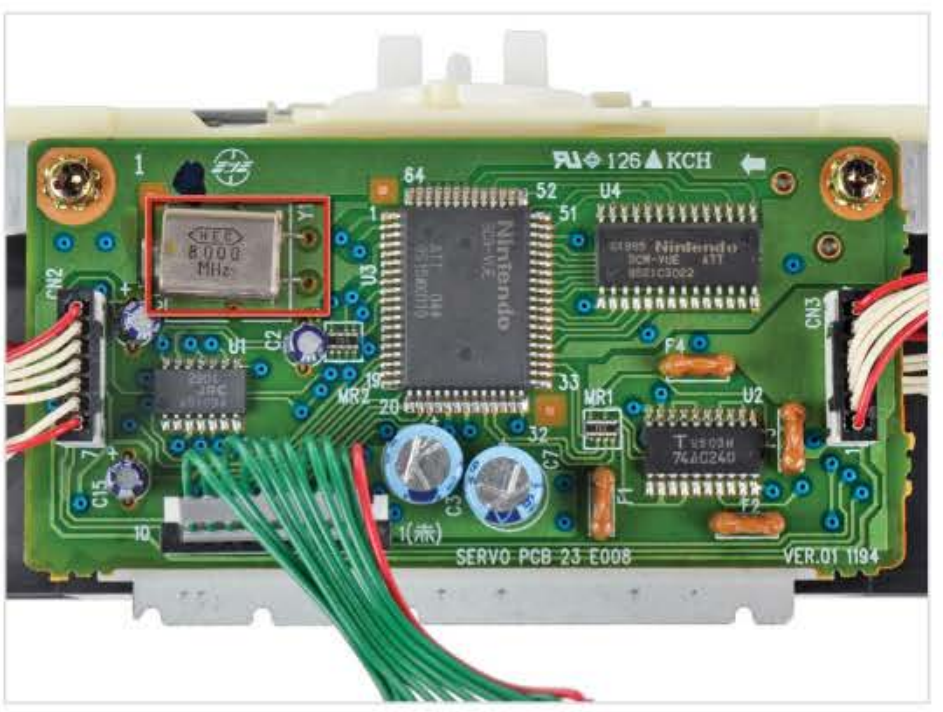
iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com.

**The Virtual Boy was only available in North America for seven months until 1996, with only 770,000 units sold worldwide. Compare that with the Nintendo 64, which sold 32.93 million units over its lifespan.**

# Nintendo Virtual Boy

**It took a while to snap this screenshot because Wario kept fidgeting.**

**An 8MHz crystal soldered to the board is used for timing the oscillation of the mirrors.**




## BACKGROUND

The Virtual Boy is a strange piece of gaming history. Nintendo called it a "32-bit, 3D experience" that "eliminates all external stimuli, totally immersing players into their own private universe." Even so, *TIME* magazine listed it as one of the worst inventions of all time, and *PC World* called it one of "the ugliest products in tech history." So let's delve into the mystery behind the Virtual Boy.

## MAJOR TECH SPECS

- 20 MHz, 32-bit RISC Processor
- 128KB dual-port VRAM
- 384 x 224 pixel resolution
- 2-bit monochrome display (black and three shades of red)
- 16-bit stereo sound

## KEY FINDINGS

- Taking the Virtual Boy apart is no walk in the park. Our 1/4" drive gamebit didn't fit into some of the recessed screw holes, so we had to get creative. After throwing sparks from our rotary cutoff wheel, we ended up with a gamebit socket that can be turned with a flathead screwdriver.
- The neoprene eye shield and its frame pop off the rear. After making short work of the screws securing the tripod base with our custom gamebit, it can be lifted off the lower case.
- After removing the rest of the screws, you can lift off the lower case. Ribbon cables attach the main board to components across the Virtual Boy. After disconnecting them, the board easily comes out. The main board takes inputs from the controller, loading game cartridge data, sending audio data to the speaker, and driving LED displays.
- A couple of Phillips screws secure the controller port and sound boards to the upper case. After removing the screws, both boards can be lifted out. The modular construction of the Virtual Boy indicates it was designed with repair in mind. A damaged controller port or audio system can be replaced individually rather than replacing the motherboard.
- A one-pixel-tall row of LEDs at the end of each display unit projects light through a lens in the middle of each unit. After passing through the lens, light is reflected off a mirror situated at 45 degrees that oscillates about its central axis. The mirror oscillates and the LED refreshes so fast that the human eye perceives a single image across the view plane.
- To oscillate the mirror, alternating electrical current at high frequency passes through a copper coil to the mirror. An iron core is attached to the display unit, forming a solenoid to produce the force. To tell the oscillator how fast the mirror is moving, an arm connected to the mirror passes through an optical sensor attached to the lower circuit board.
- Two T10 Torx screws secure the LED unit to the end of the display assembly. After the LED unit is removed, you can see the periscope-style reflection and slight magnification caused by the mirror and internal lens. Each four-color display unit features a 1 x 224 pixel resolution with 32 levels of intensity. Each "image" produced is a row of red dots. Used with the oscillating mirror, a full image is created.
- Repairability score: 6 out of 10. Modular design makes replacing ports easy. Phillips and Torx screws inside can be removed with the right drivers. Many components can be lifted out with little effort. However, opening the casing requires a specialized tool that took time to replicate.

# Benchmark your GPU like Maximum PC

## YOU'LL NEED THIS

**A PC OR LAPTOP WITH A DISCRETE GRAPHICS CARD**
A screen, mouse, keyboard, and internet connection. Some money to spend on benchmarking software.

**LAST ISSUE**, we showed you how to benchmark your CPU just like the system-testing impresarios here on *Maximum PC*. Never let it be said that we can't follow a theme; this time, we'll be running through the tests we use to benchmark GPUs, for both builds and reviews.

Unlike our CPU benchmarking process, some of this software isn't available for free. Free trials are available for certain programs, but GPU testing ideally uses multiple gaming benchmarks, which could cost you. We'll go through some of the games we use for testing later on, but if you don't have any of those you may want to look into whether any of the titles you already own include a benchmark. Plenty of games have one nestled away in the graphical settings to let you double-check you're getting optimal performance from your machine.

It's worth noting that the following benchmarking tests are ones we primarily use for testing on discrete GPUs, not integrated graphics on CPUs. Many of these tests can be run on modern IGPUs without issue—albeit generating very low scores—but take care if you do want to stress test your chip's graphics. These tests can push IGPUs to their limits, and you don't want to risk damaging your processor (or your whole system) due to overheating. **–MAXIMUM PC**

**»» Even the mightiest of GPUs need testing from time to time.**

### 1 STRIKE WHILE THE IRON IS HOT

We're going to jump straight in with 3DMark from UL Benchmarks. This is the single most comprehensive and widely acknowledged graphics test available right now, with a large variety of comparative score tables available online for any class of PC. 3DMark is available online (or through Steam, for added convenience), and the Advanced Edition costs $30.

»» It's no small investment just to test your graphics card, sure, but 3DMark is a powerful and comprehensive piece of software; shell out for the Advanced Edition and you get multiple tests, each designed to test systems with varying levels of graphical power. Our go-to test here is Fire Strike, a multipurpose DirectX 11 gaming test for discrete GPUs. Fire Strike takes a little while to run, rendering some cool fight scenes in a sci-fi landscape. It's fun to watch—for the first few times, at least.

»» If you open up 3DMark and head to the "Benchmarks" tab, you should be able to launch Fire Strike by simply selecting it and hitting "Run". If you've got the Advanced Edition, you should also have access to Fire Strike Extreme and Fire Strike Ultra; while the regular version of the benchmark runs at 1080p, these run at 1440p and 4K respectively. We'd avoid them unless you have a high-end GPU, as they kick the living daylights out of your card.

»» Fire Strike has the same composition as most of 3DMark's tests; first, it tests graphical rendering, then physics, then finally a combined stress test. It then spits out a number that will at first appear meaningless, but don't despair; this is your system's index score, and you can use 3DMark to compare it to other, similar machines. There are also high-score leaderboards, where tweakers with overpowered PCs compete for the best performance.

### 2 RAY-TRACED TESTING

3DMark offers more specific tests, too. If you are running on integrated graphics (or an older system), you might want to check out Sky Diver, a graphical test similar to Fire Strike, but for lower-spec machines. Time Spy and Night Raid offer similar tests, but for systems running DirectX 12 in games. There's also Port Royal, which is used to test the ray-tracing and DLSS capabilities of PCs with Nvidia's RTX GPUs.

»» There's more specific options, such as tests for GPU API overhead and a PCIe test to demonstrate the improvements in PCIe 4.0, but we won't get stuck into that now as we don't typically use these in a standard GPU test. Ray tracing is still of interest, though.

»» For a more practical test of the ray-tracing capabilities of a GPU, we use a game: Deep Silver's

**»» Fire Strike is our go-to benchmark test for any new GPU.**

© UL BENCHMARKS

# FRAME RATE CHECKING

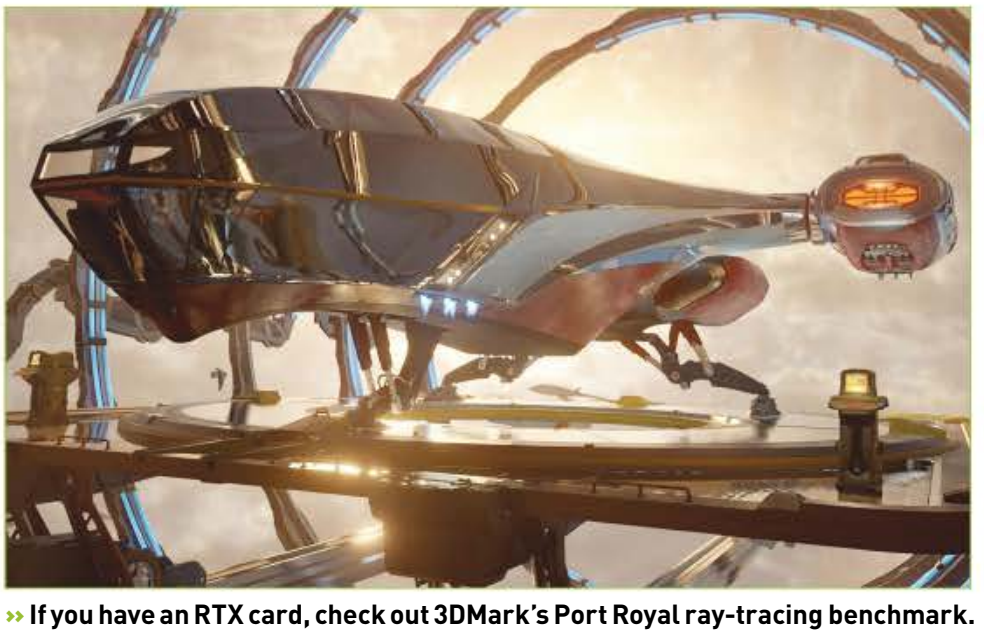
For real-time tracking of frame rates in games, you may need some extra software. While some games include live fps counters (like *Destiny 2*), you'll likely need to activate a separate overlay to monitor your frame rate while playing. If you're on Steam, then good news: Steam packs an in-game overlay that includes an fps counter. You can turn it on under "Settings → In-Game," and then it'll activate automatically in any game you boot up. You can't turn it on while playing, though.

Otherwise, you're going to need some external software. Unfortunately this does mean there's a bit of extra load on your CPU, but you shouldn't notice much of a difference on modern systems. The GPU overclocking software MSI Afterburner is our go-to program for this, as it can display a number of other live stats in an overlay. It's free to download and can be used to track things like GPU temperatures and clocks, as well as your frame rate. Afterburner is, however, a rather arcane piece of software. The UI is busy and unnecessarily stylized, which might prove annoying for some. Thankfully, there's a good alternative for those who like to keep things simple.

Fraps (known as FRAPS, if you like yelling) is another piece of software that can be used for monitoring your frame rate. Its primary use is for screenshot and video capture, but the free version enables you to pop up an fps counter on a hotkey when you're gaming. It's useful for making checks if you're experiencing frame drop, but easy to hide so your UI won't get too cluttered in games.

Fraps might look and feel a bit dated, but it's an effective tool, with a simple, easy-to-use interface that won't bash your CPU while it's running, so we recommend it. If you're not looking to overclock your GPU, we'd recommend it over Afterburner.

*Metro Exodus*. This benchmark is quite fiddly to run: while most games will simply include a benchmark somewhere in the graphical settings menu, the *Metro Exodus* benchmark is hidden away in the game files on your PC. Assuming you haven't moved the files around, you'll find it in your installation folder for the launcher (be it Epic or Steam), under *Metro Exodus*. It's simply called "Benchmark.exe", but if you run it as an administrator you'll be met with a settings menu before the test begins. Select your target resolution and graphical level—we usually test at 1080p Ultra—and then run the benchmark. It will render a set cutscene demonstrating a range of effects, from particle physics to lighting, then give you an average frame rate.



© MSI

**»» If you have an RTX card, check out 3DMark's Port Royal ray-tracing benchmark.**

»» Averaged frame rates in games are the most useful piece of information about any GPU. Any game benchmark should be designed to give you an average frames-per-second score that matches your actual in-game experience, although it's also worth noting the minimum fps the test hits; this will give you an idea of any frame rate drop you might experience. With *Metro Exodus*, you can turn on ray tracing (while leaving the other settings intact) and run the test again to see how much using the RTX features will affect your frame rate.

## 3 KEEPING SCORE

Getting benchmark results is great, and frame rates are even better. But it's vitally important to keep track of not just how well your GPU is performing, but also how hot it's getting—doubly so if you're overclocking that GPU. A word to the wise on overclocking; do your research first, as many graphics cards won't give you much better performance on a manual overclock compared to the factory boost option, and your GPU's thermals are almost guaranteed to rise higher on a manual overclock.

»» We don't manually overclock GPUs during any testing we do, but we do take advantage of any automatic boost options available through manufacturer software, and we always make sure that the card is running the latest drivers. If you're benchmarking your system to check your overclocking performance gains, ensure that everything you're running is up to date, from the drivers to the benchmarks themselves.

## BUDGET BENCHMARKING

While most of the software and games we've listed here aren't free, there are still ways to test your GPU's capabilities without spending a dime. 3DMark has a free edition with limited features, but if you don't want to pay, we'd recommend Unigine's Heaven benchmark. The Heaven benchmark is a heavy-duty graphics test that can be used for systems running DirectX 11 and OpenGL 4.0, testing all the usual elements, such as ambient occlusion and real-time lighting. A free "gamer: edition" of the benchmark is available online, with the paid versions offering additional (often unneeded) features, such as benchmark looping and frame-by-frame analysis. Heaven is straightforward to set up and run, and comes with a few useful GPU monitoring tools too.

Another way to benchmark your system is to use free-to-play games in conjunction with fps-monitoring software (see "Frame rate Checking"). Using MSI Afterburner to track a continuous average fps and then playing a few matches in *Fortnite* will give you an idea of what your GPU can handle. Be sure to pause fps tracking when you're on menus and loading screens, as this won't be indicative of a real gameplay frame rate. Other free games that are worth checking out for fps testing include *Call of Duty: Warzone*, *Destiny 2: New Light*, and *Counter-Strike: Global Offensive*. We're also gonna give a shout-out to *World of Tanks*, as it has a built-in benchmark—a rare sight in free-to-play games!

PassMark PerformanceTest is a popular option for GPU benchmarking (and system testing as a whole). It's not free, but a trial version is available that should enable you to check if your GPU is performing as expected. Leaderboards for GPUs are available on the PassMark website too, which is useful if you're trying to overclock for max performance.

» For keeping an eye on your GPU temperature—among other things—when benchmarking, we recommend HWMonitor (also known as HardwareMonitor) from CPUID. It's a free download with no in-program ads, simply displaying a wide variety of live operating statistics for your PC. The UI is as basic as they come, and there aren't any extra features: just the numbers, with a running minimum and maximum on screen until you reset it.

» The live figures are helpful for quickly checking temperatures, but the tracked maximum numbers are what help us during testing. Open up HWMonitor and leave it running in the background as you run a benchmark, then check what maximum GPU temperature your system reached during the test. Keep an eye on this, as different benchmarks will push your GPU to varying temperatures. If an intensive test pushes your card to very high temperatures, it may be a sign that it isn't up to the task. You can reset the min-max recording to run another test under View → Clear Min-Max. We advise that you give your GPU a few minutes to return to its standard running temperature in between benchmarks, as it may affect performance otherwise.

### 4 SCHEDULED MAINTENANCE

While we're talking about temperatures, when was the last time you dusted your GPU? It's always a good idea to clean your system before any benchmarking process, to ensure that you're getting the absolute best performance possible out of your rig. Crack open that case and use an air duster to blast away any build-up on your fans and around your GPU, and clean any removable dust filters your case has. If you're tracking temperatures, you're also going to want to prep by doing a little research first; you'll be able to find the maximum GPU temperature on the manufacturer's website, so you'll know if your card is pushing the heat limit with your benchmarks. You can also check the GPU power draw, but your PSU should have plenty of overhead for stress-testing or even overclocking; this is something to be mindful of only if you have an older or low-power system.

» One last bit of housekeeping you may want to do before you sit down to start benchmarking is hopping into the motherboard BIOS. Some BIOS firmware updates can improve GPU performance and stability (albeit only by a small amount), so ensure that your motherboard is up to date. You may need to download a new BIOS update file to a USB drive in order to flash and update the BIOS, but if you're lucky your motherboard will come with the functionality to download and install any updates within

›› The Division 2's built-in benchmark is super easy to run.

›› Metro Exodus has dank caverns to show off ray-traced illumination.

›› Fortnite isn't very demanding, so it's a great way to test an older GPU's performance for free.

the BIOS. While you're there, check that your system's fan curves are set to hit full speed at maximum system load.

## GAMING ON

As any regular reader of *Maximum PC* will know, we use a number of other games when benchmarking systems and GPUs. One of the most useful is *Total War: Warhammer II*. As is the case with many strategy games that demand the generation of hundreds of on-screen units simultaneously, this game is CPU-bound to a certain degree, and as such can give noticeably different scores depending on the processor being used, not just the GPU. It's easy to run: just fire up the game, and under graphics settings you'll find an "advanced" button. Here you'll find the benchmark button, which lets you choose between three different scenes to render. We use the standard "battle" benchmark for our tests.

›› Another title we use for testing is *The Division 2* from Ubisoft. This benchmark is similarly simple to run—just hop into the settings in-game, set your target specs, and hit "Run Benchmark." As always, we run at 1080p with maximum settings. If you're testing out lower-spec systems, you might want to experiment with medium, low, or minimum settings for these tests. Dropping your resolution to 720p will also boost performance significantly, but the cost of graphical fidelity is a tad high for us.

›› Other games, such as *Tom Clancy's Ghost Recon Wildlands* and *Assassin's Creed Odyssey*, are ideal tests because they are graphically demanding, and as such will provide a good litmus test for whether your PC can handle modern AAA releases. Both of these have a benchmark that's easily accessible in-game through the graphics settings, along with a useful bonus from Ubisoft: a video memory budget meter that fills up as you turn up the graphics, warning you when you're hitting the limits of what your GPU is capable of.

›› One game you might have noticed missing from this list is *Rise of the Tomb Raider*, which we often use to test desktops and laptops. While the benchmark in this can be run instantly from the main menu, we don't advise using it, as many of the finer settings can cause hard-to-track frame rate tweaks that don't always correlate to similar performance on different systems. It's a capricious one, for sure. Everything else we've talked about here is fair game, though, so fire up that PC!

© DEEP SILVER, UBISOFT, EPIC GAMES

# Secure Messaging with Retroshare

### YOU'LL NEED THIS

**RETROSHARE**
Download this free, open-source software from www.retroshare.net

**A FRIEND**
You need at least one privacy or security-conscious friend.

**IN THE PRESENT ONLINE WORLD**, our data is continually copied and stored as we navigate the digital landscape. Big corporations, government agencies, and hackers all work continuously to erode our privacy and security, whether it's by latching onto unencrypted communication or stealing personal information like email addresses or passwords. In order to help keep your online communications secure, Retroshare offers a "secure decentralized communication platform," using a variant of P2P technology called F2F, or "Friend-to-Friend". With Retroshare, you can build a private network of people you know without anyone else—including your friends—knowing who's in it. This means no central servers for storing multiple users' sensitive information, and no easy target for anyone looking to pillage your data.

Retroshare contains tools for instant messaging, private mail, secure P2P file sharing, and public and private chat channels, with some allowing your friends to view your name and IP address, while others function completely anonymously. While Retroshare has a messy, cluttered UI that buries some useful settings, there's a wealth of tools available within this single piece of software. It might seem intimidating at first, but fear not; we're here to help you navigate this powerful tool and resecure your digital privacy. –**NICK PEERS**

## 1 SET UP PROFILE AND FIRST NODE

Head to www.retroshare.net and download the latest Qt4 version, because it's the same user interface found in the Mac and Ubuntu versions. Once downloaded, double-click the setup file and follow the prompts—you have the option of installing it as a regular application, or as a portable app.

›› Launch Retroshare, and create a new username and password [**Image A**]—the stronger the better. Keep moving your mouse randomly around the screen until the progress bar is at least 20 percent (but aim to reach 100 percent). Once you're happy, click "Generate new profile and node."

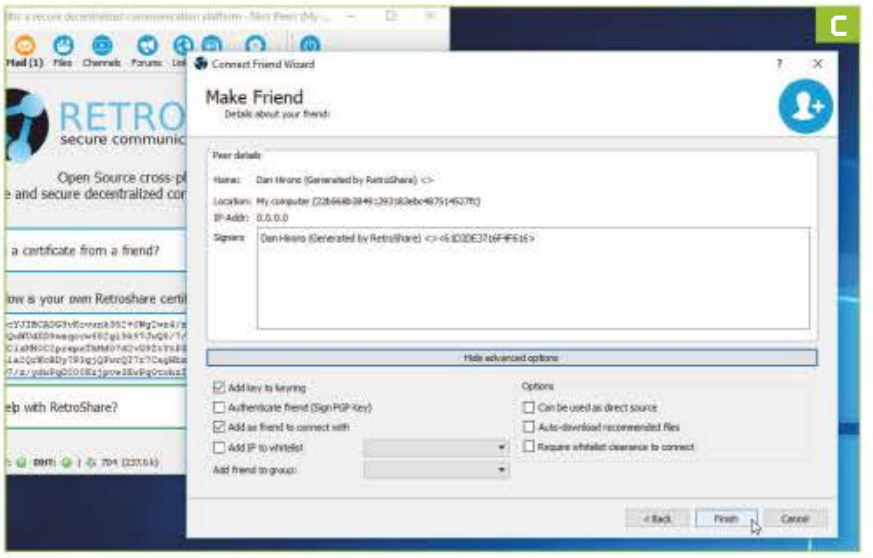
## 2 SWAP CERTIFICATES WITH A FRIEND

Close the welcome screen to view your Retroshare certificate—a lengthy string of alphanumeric characters and symbols. Click the Retroshare icon above it to reveal five different ways to make friends [**Image B**]. We're assuming you're following this tutorial with a friend, so choose one of the two ways to share your certificate: either via the clipboard (which you paste into another document or application), or a file. If you choose the "Save your Cert into a file" option, save it with a *.rsc file extension, then transfer it securely to your friend—either physically (via USB flash drives, say, or even a printout), over a local network share, or perhaps via another secure messaging platform, such as PGP-encrypted email.

## 3 MAKE CONNECTION

Once you've received it, click "Add friends certificate." You can type it in painstakingly by hand, paste it from your clipboard, or click "Open certificate" to open the certificate file they've shared with you. Click "Next," and you'll see that it's signed by the name of the person it purports to be from. If you're not 100 percent convinced of the origin of the file, click "Finish." But if you're happy with its veracity, click "Show Advanced options," and check "Authenticate friend (Sign PGP Key)" [**Image C**]. This adds your proof to the key that it's genuine, to help others decide whether it's safe or not. If you've decided to authenticate the key, you need to enter the password you created in step one after clicking "Finish."

B
RETROSHARE
secure communication for everyone
Open Source cross-platform,
private and secure decentralized communication platform.
Did you receive a certificate from a friend?
Add friends certificate
The text below is your own Retroshare certificate. Send it to your friends
Copy your Cert to Clipboard
Save your Cert into a File
Send via Email
Invite via WebMail
Recommend friends to each others
Do you need help with RetroShare?




## 4 COMPLETE CONNECTION

A Connection Assistant opens, which sets up your network connection. When it's online, it confirms you've reached your friend. You may need to prod your friend via their "Log" button to accept. When done, you'll see a "Congratulations, you are connected" message. Click "OK," then switch to the "Network" section, where they're listed under "Friend Nodes." Repeat for any other friends.

›› Go to the "Network" section, and switch to the "Network graph" tab. You'll see how you're connected to your friends, but that they're not (yet) connected to each other. This serves as a reminder of how Retroshare's F2F network works: All connections are individual; you don't simply gain access to another person's set of friends.

## 5 LINK FRIENDS TOGETHER

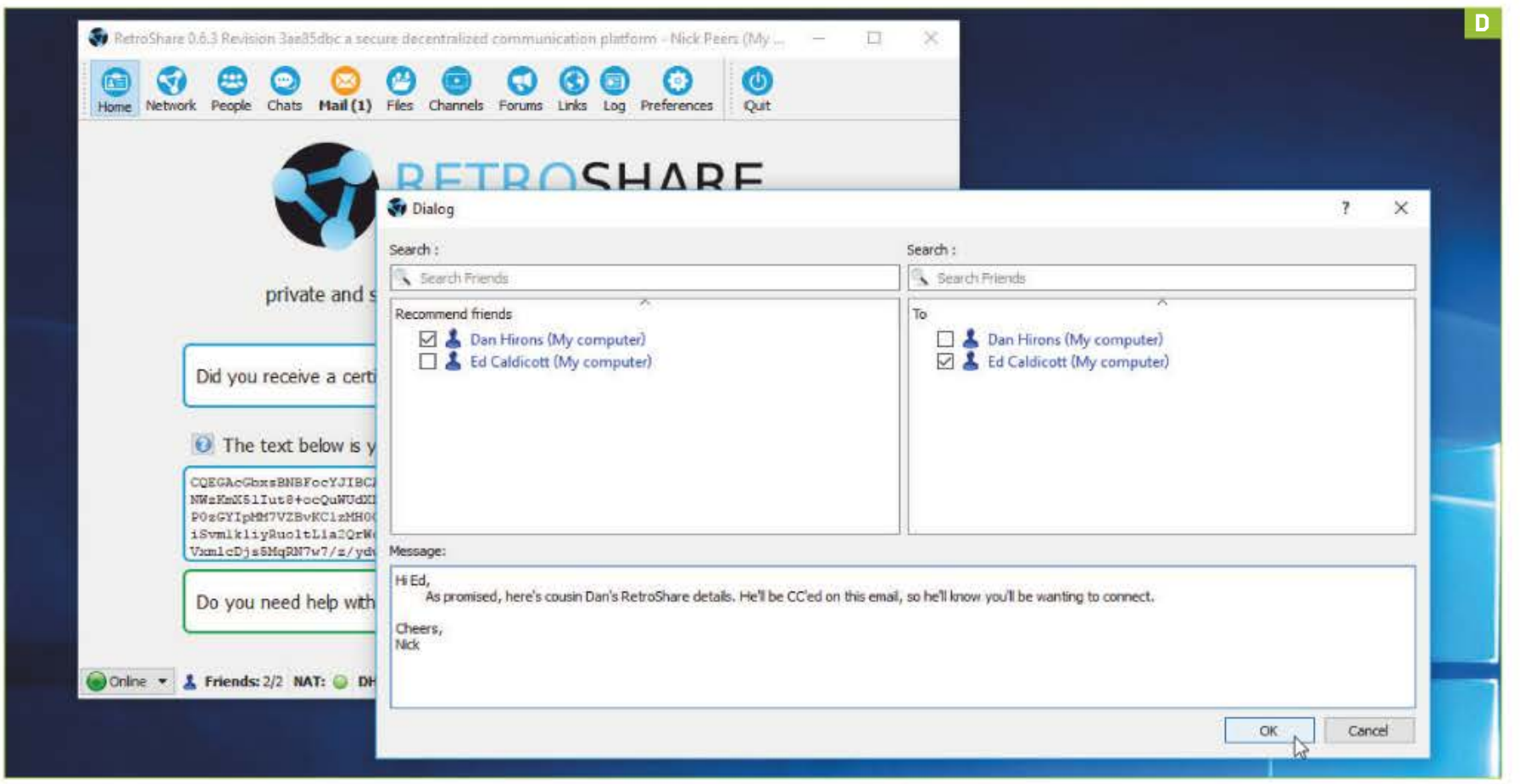
Friends can—if they wish—connect directly, too. This is done via the "Add" button from the "Home" section. This time, choose "Recommend my friends to each other." You need to check the boxes of those you wish to introduce in both "Recommend friends" and "To" [**Image D**]. Your friends then receive two messages in their Mail box, one directed to them, and the other where they've been CCed. They need to open the message directly addressed to them, where they'll see the other

# WORKING WITH NODES

To use Retroshare on more than one computer, you need to transfer your profile. First, export it from your PC: Select "Network → Keyring," right-click your profile entry, and choose "Export/create a new node," then "Export selected key." Save the .asc file, and transfer it to your new computer.

Open Retroshare on the second device, and click "Option → Advanced options," then "Option → Use existing profile." Load in your .asc file. This pre-fills the profile name—give your node a name to differentiate it from your main PC, then enter your password, move the mouse about, and click "Go!"

By default, each node shares your name, PGP ID, and PGP fingerprint, but they're assigned unique location IDs. Each node is, by default, isolated from the others, so you can choose who gets to contact you on each node. The quickest way to copy all your friends across is via the "Network" section. Right-click "Trusted nodes" (or a group name), and choose "Export friendlist." Transfer the exported file across, then re-import it into your new node from the same dialog.



## TIPS AND TRICKS

As if Retroshare's existing features weren't enough, it's possible to expand it further using plugins. Two are included with the Windows version but are disabled by default. Navigate to "Preferences → Plugins," and click "Enable" next to the VoIP.dll plugin to add voice and video chat to Retroshare's "Network" button; enable FeedReader to set up an RSS feed for your own use or to share via a forum. Once enabled, configure both via their own sections in "Preferences" (in the case of the VoIP plugin, both you and your chat partner need it to be installed and running to use it).

Retroshare comes with a built-in web interface, giving you access to a limited subset of its features through your web browser. Navigate to "Preferences → Webinterface" to enable it. By default, you're limited to access through the computer Retroshare is installed on; check "Allow access from all IP addresses," and you can then access it from other computers on your local network using their IP address, and the designated port—for example, 192.168.0.3:9090.

person's Retroshare certificate has been attached: Just click this to add it in the usual way.

### 6 REVIEW CONNECTIONS

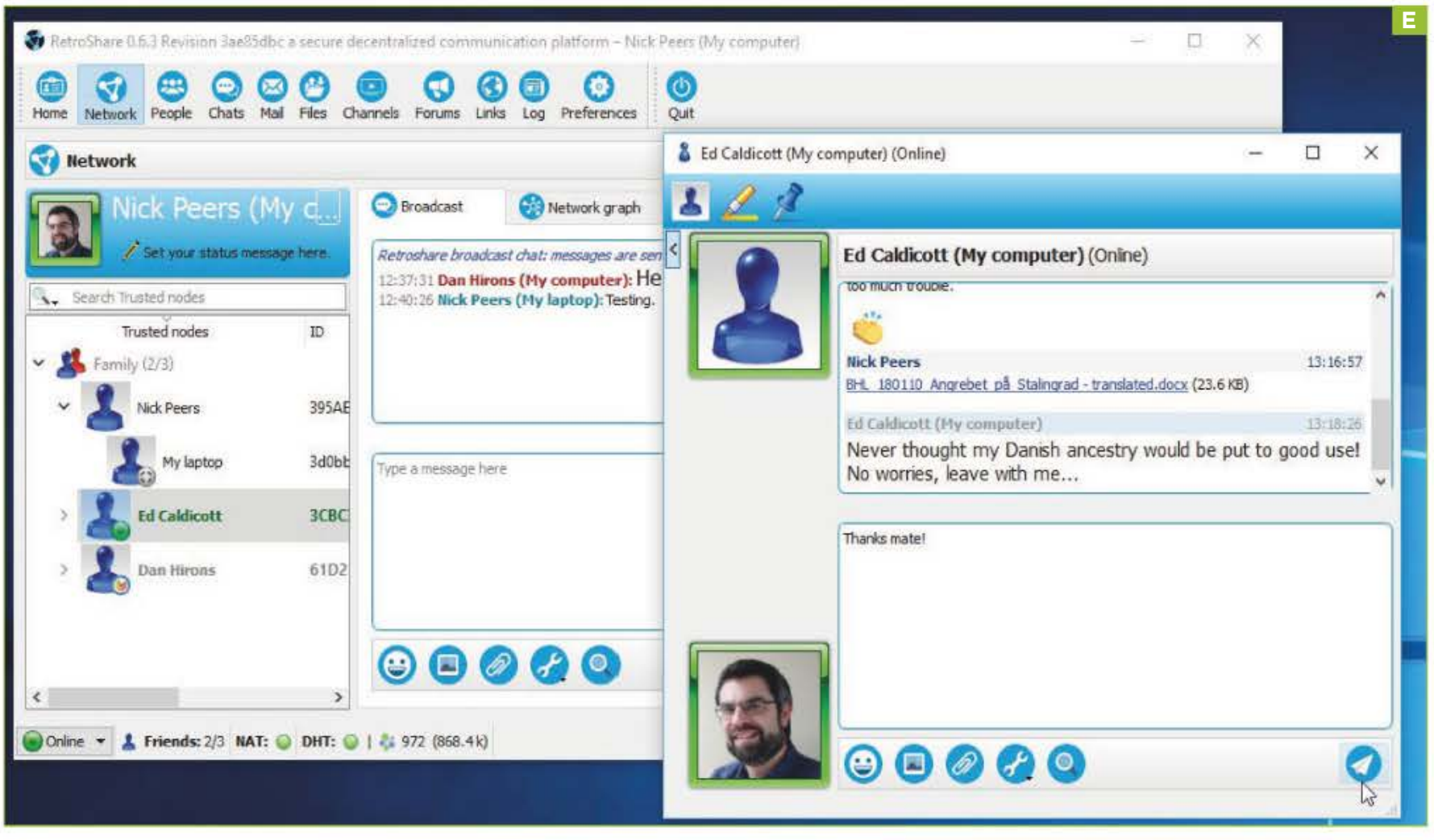
Once your friends are connected to each other, switch to the "Keyring" tab under "Network" to review all the keys you've received—look at the Trust level. "Personal signature" refers to the fact that you received the certificate directly from them, while "Untrusted peer" indicates that you connected through a third-party introduction.

›› If you're confident the person is who they appear to be, right-click their profile, and choose "Profile details." You'll see a list of people who've signed the key, plus a "Trust level" drop-down menu—click this to indicate your confidence in this person. If you trust them implicitly, click "Sign this key" if you haven't already—when you then introduce them to other people, they'll see you've signed their certificate, indicating they're genuine.

### 7 USE RETROSHARE FOR CHAT AND MESSAGING

The "Network" tab doubles up as Retroshare's instant messaging client. Double-click a person in the left-hand window to open a message window, then use the tools to chat with them. It works in a similar way to Skype and other IM tools—chat, add smileys, swap photos and files, and so on. You can search your chat history, plus save, clear, or delete it [Image E]. You can also send a message to everyone currently online in your nodes list using the "Broadcast" tab. Type a message, and it appears in the "Broadcast" tab.

›› Right-click a person's name, and you'll see various options, including one for organizing them into groups. Several presets—co-workers, family, favorites, and so on—are provided, or you can create your own. This enables you to name your group, plus quickly file people into it. You'll then see people filed accordingly in the list.



» Switch to the "Mail" section, and you'll see that Retroshare can also be used as a private email service between you and your contacts. It works in much the same way as regular email, with messages held until you're both online and logged into Retroshare, at which point they're delivered.

## 8 SHARE FILES SECURELY

Another use for Retroshare is as a P2P file-sharing tool. Switch to the "Files" section. Click "Configure shared directories" to edit the default directory (where files you download from others appear), and add more. Click "Add new" to select (or create) your new shared directory. Double-click "[Unset]" under "Visible name" to give it a name that others will see when they are browsing the "Friends files" tab of their "Files" section.

» The default settings for file searching (no anonymous searches) and downloading (using anonymous tunnels) are best left alone. Note that content isn't visible to your contacts unless you double-click the green button. By default, all can now view it, so right-click "[All friend nodes]," and choose "Change group visibility" to make it visible only to a subset of your contacts using the groups from the previous step. You can set up multiple shared folders with different access controls for each—click "Apply and close" when you're done.

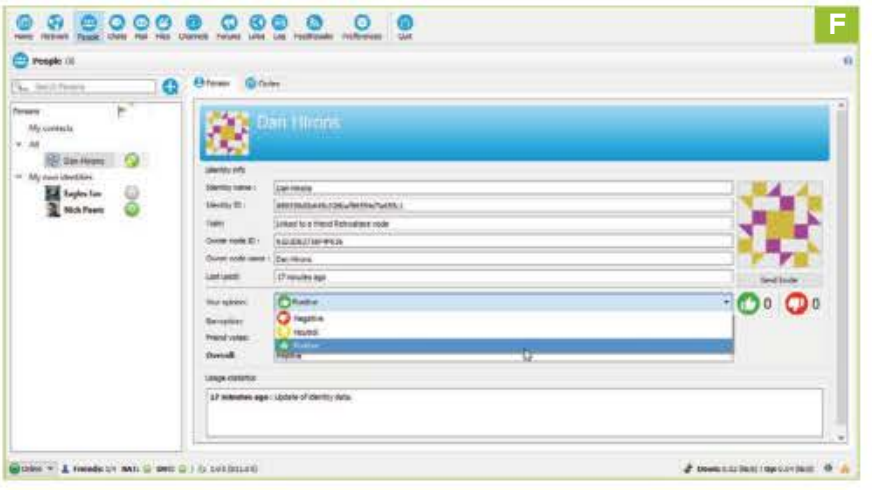
» Now simply copy files into this folder, and other users can download them via the "Friends files" tab. Use the "My files" tab to review what you're sharing; expand the shared directory name to view the contents of the directory. It can take a little while for new files to appear—click "Check files" to force a refresh of the view. You can also group files into "collections"—this is a simple file you can distribute to others. When they click on the collection, the files listed in it are automatically downloaded into the same folder structure you've set up inside the collection.

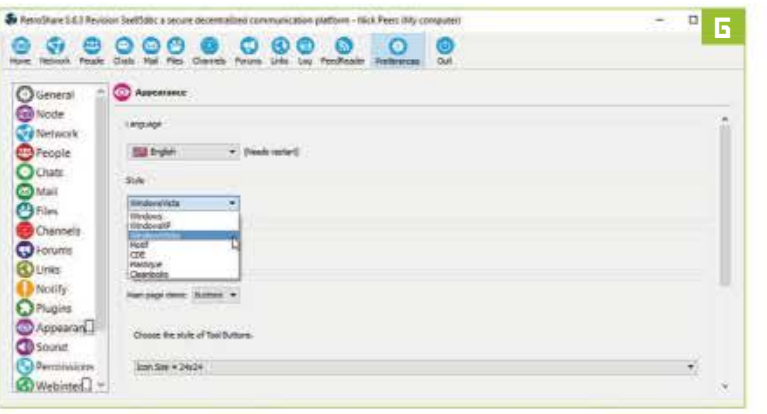
» If you encounter sluggish Internet speeds because too many people are grabbing your files, go to "Preferences → Network" to set a universal bandwidth limit for uploading files, or right-click a contact and choose "Profile details → Options tab" to set restrictions at an individual level. Keep an eye on the "Down" and "Up" levels in the bottom right-hand corner of the main Retroshare window to see what's going on.

## 9 BUILD IDENTITIES

Switch to the "People" section, where you create profiles to identify yourself in other parts of Retroshare. Use the "Person" tab to view your own identity as it's seen by others you're connected to. Right-click it and choose "Edit identity" to modify it—change your nickname and set your avatar or photo.

» You can also create new identities that sit alongside your existing ones—to do so, click the "+" button next to the "Search Persons" box, and choose "Create new Identity." By default, the identity is "owned" by you, so while you provide a nickname and avatar, your




profile details are also available for others to see. You can also create completely anonymous "pseudonyms"—provide a nickname and an avatar, but relax in the knowledge that there's nothing to link them back to your own profile.

## 10 ADD TO CIRCLES

By default, other people's identities don't appear under "People." You can rectify this by way of the Circles feature. First, click "+" and choose "Create new circle." Give your circle a suitable name, and leave it set to "Public"—this ensures your contacts (but no one else) will be able to see you and your new circle in their "People" section. Select an identity linked to your profile in the right-hand pane, and click "<" to add it to the list of invitees, then click "Create."

» Now switch to the "Circles" tab, and expand "Other circles." Expand your circle, right-click your name, and choose "Accept this invitation" to join the circle. It now moves to the "Circles I belong to" section, and both the circle and your contacts will be able to see your identity. They can right-click the circle and choose "Request subscription." If you accept their request via the "Circles" tab (when their name appears, right-click and choose "Grant membership"), they'll show up in your "People" list, too [**Image F**].

## 11 AND THERE'S MORE

Set up private chat rooms via the "Chats" button—click "+" to set one up. You can choose an identity to use, whether it's public (all your friends) or private (invitation-only), and ban pseudonyms (check "Required PGP-signed identities"). Chat rooms work much like the one-to-one instant messaging tool, only for larger groups.

» Retroshare also offers channels—a mechanism for spreading data around your network. The channel's creator is the only person who can post to the channel, but others can download your content, and you can enable comments, too. Note that public channels go beyond your friend network—stick to circles or node groups to limit who has access.

» Forums work in the same way as regular Internet forums, except everything is, of course, encrypted and decentralized. Links are another variation on the same theme. In short, we've barely scratched the surface of what Retroshare can do. It's incredibly flexible, with each section packed full of hidden tips and tricks—click "Preferences," and work through the sections to discover even more tweaks and settings to apply [**Image G**]. Head over to https://retroshare.readthedocs.io/en/latest/user-guide/interface and work your way through the various sections, where you'll gain advanced insights into features we've covered, plus learn about the other sharing tools that we've only touched upon.

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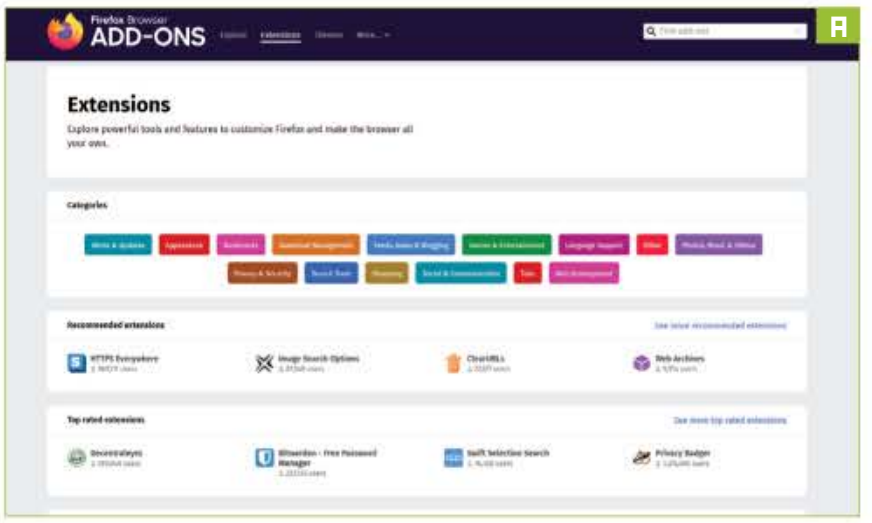
# Pick the Best Firefox Extensions

### YOU'LL NEED THIS

**FIREFOX**
Download the free web browser
www.mozilla.org/en-US/firefox/new/
Firefox extensions can be found at
https://addons.mozilla.org/en-US/firefox/

**TIRED OF GOOGLE CHROME**, but worried that you won't have access to those extensions you use if you change? Or perhaps you've already swapped to Firefox, but need some advice on which extensions you should pick up [**Image A**]? Don't worry, *Maximum PC* has got your back.

Extensions are the best way of customizing your browsing experience. Not only can they adjust and alter your themes and the look of websites, but many also provide useful utility features and privacy extras that the stock browser doesn't allow for. We're going to give you the lowdown on our top 8 must-have Firefox extensions, for those ready to ditch Google's dominant web browser for something a little sleeker and more private. **–ZAK STOREY**




A

## 1 UBLOCK ORIGIN

All web browser setups should start with a dependable ad-blocker. Now we're not saying don't support the websites you love. After all, most sites–our own included—rely on ad revenue and affiliates to keep producing the content you enjoy, and less money means less quality control. However, the decision of who you support should be entirely up to you. uBlock Origin is a fantastic open-source ad-blocker that's regularly updated and easy to configure, with minimal impact on system performance. And if you do want to support a site, you simply click on the on/off switch in the extension window, and ad-block will be disabled for that site.

## 2 HTTPS EVERYWHERE

HTTPS offers better end-to-end encryption than the HTTP, and most websites support some form of HTTPS, although they don't always default to that. HTTPS Everywhere rewrites all browser/webpage requests to switch to HTTPS, so you can be sure that wherever you go you'll be encrypted on either end.

## 3 DISCONNECT

Disconnect is a great extension that works on top of uBlock Origin to stifle any cookies or ad-tracking that occurs as you browse the web. Many companies purely exist to sell your data and cookies to one another, to "improve" your advertising experience and try to get you to purchase more things based on your viewing habits. Disconnect aims to stop that, and is another open-source extension that works alongside traditional ad-blockers.

## 4 FACEBOOK CONTAINER

Ahh that pesky Facebook causing trouble. Facebook is useful: Staying in touch with friends and family in these trying times is certainly important. However, its intrusive web-tracking and cookie management is less enjoyable. Remember, it also owns Instagram and works with other sites (namely Amazon) to pass on your advertising details via cookies. A good counter to that? The Facebook Container extension. It'll delete all of your Facebook cookies and log you out. On next login, it'll isolate the page in its own container. If you click an external link within Facebook, that URL will load outside of the container, making it more difficult for Facebook to track you.

## 5 AMAZON CONTAINER

Similarly, the Amazon container isolates your Amazon activity within its own container tab. This is a fork on Mozilla's Facebook container and ensures that no third-party cookies can follow your internet browsing habits as you move across the web.

## 6 LASTPASS: FREE PASSWORD MANAGER

We highly recommend you use something like LastPass for your passwords. It's highly secure, lets you generate complex passwords on the fly, and it's free in its basic package. Its extension will autofill any username and password slots, ask if you want to update the password information on detection of a new or changed password, and is very quick and easy to use. It's worth a look if you're using a single password for all your accounts (which is definitely a bad idea), and can't be bothered with the hassle of noting new passwords down.

## 7 CHECKER PLUS FOR GMAIL

This adds an icon in the top toolbar to show you if you have any new emails, and notifies you when you get a new one. Click on it to open a small window preview of your inbox—you can open emails and read and respond there if you need to. It also supports multiple accounts.

## 8 UNDO CLOSE TAB

The lack of an "Undo Close Tab" button or easy-access History page is perhaps Firefox's one weakness compared to Google Chrome. However, you can pick up a neat little extension called Undo Close Tab. Click the arrow icon in your toolbar and it'll open the last tab you closed; click it again and it'll open the one before that, and so on. Alternatively, right-click it to open a menu that shows you all of your recently closed tabs.

© MOZILLA

# Getting Started with Arduino

## YOU'LL NEED THIS

**AN ARDUINO NANO 33 IOT OR LEONARDO A BREADBOARD**
2x M2M jumper wires.

***PROJECT 1*: AN LED 330 OHM RESISTOR**
(Orange-Orange-Brown-Gold)

***PROJECT 2*: PUSH BUTTON / MOMENTARY SWITCH**
(Any type should work here.)

**HERE, WE HAVE TWO SIMPLE PROJECTS**. The first tests that we can wire up a simple circuit, while the second project enables our Arduino to emulate a USB keyboard, which we will then use to quickly change the screen when our boss walks in. There are two ways to code the Arduino: via an online editor, or via the traditional Arduino IDE (integrated development environment).

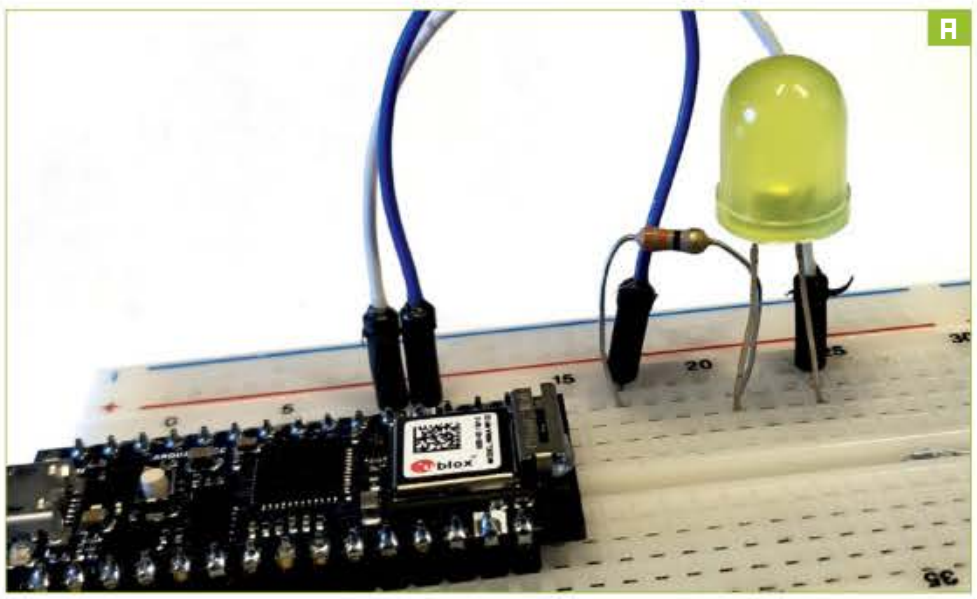
Plug in the Arduino Nano 33 IoT, then in a browser visit https://create.arduino.cc and create a new account. Follow the instructions, and when prompted, download and install the Arduino Create app. The app will detect the board and make it available to the Arduino IoT Cloud. You'll be asked to set up the crypto chip on the Nano 33 IoT; this is essential for a secure connection to the cloud. If you're using another Arduino board, the installer will skip this section.

If you wish to use the Arduino IDE, go to www.arduino.cc/en/Main/Software and download the IDE for your system. Then follow the online instructions to install the IDE to your desktop.

One issue is that your user may not be not be in the correct group to send data to the Arduino; to fix this, open a terminal and type the following (change <username> to your user name):

```
$ sudo usermod -a -G dialout <username>
```

Then reboot your computer before proceeding. In this tutorial we will be using the Arduino IoT Cloud, but the code is transferable between the two editors. –**JONNI BIDWELL**


A

## 1 PROJECT 1: HELLO WORLD

The most basic project we can create is to flash an LED. But why do that? Well, it confirms that we can send data to the board, and it also confirms that our electronic components work [**Image A**]. The circuit for the project involves an LED, breadboard, 330 Ohm resistor, and two male-to-male jumper wires. The LED is placed into a breadboard, and the resistor is connected to the short leg (the cathode, –, GND leg) and to the GND pin of the Arduino via a jumper wire. The long leg of the LED (Anode, +) is connected to pin 2 of the Arduino via another jumper wire.

## 2 CODING THE PROJECT

In the Arduino IoT Cloud, click "Arduino Web Editor" and then connect the Arduino to your computer. Create a new sketch in "Sketchbook". The first step is to create a function that will tell the Arduino that we wish to use pin 2 as an output to send current to the connected LED.

```
void setup() {
 pinMode(2, OUTPUT);
}
```

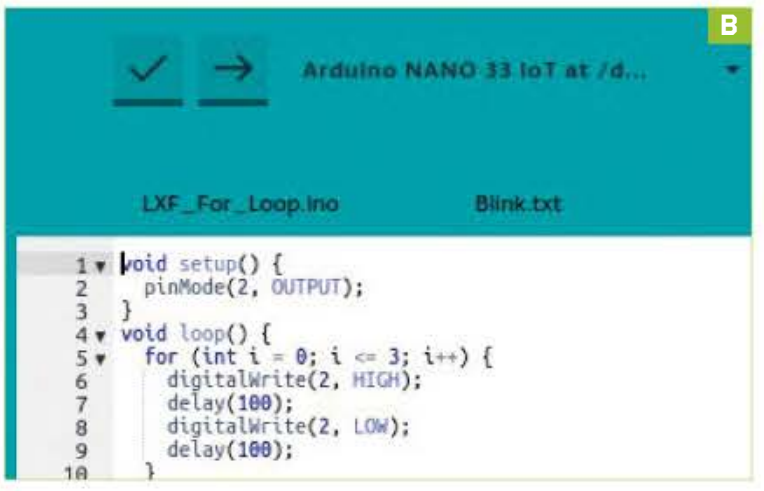
» Our loop will run the code forever, and inside the main loop is a `for` loop, which will iterate (go round) three times and quickly flash our LED before pausing.

```
void loop() {
  for (int i = 0; i <= 3; i++) {
```

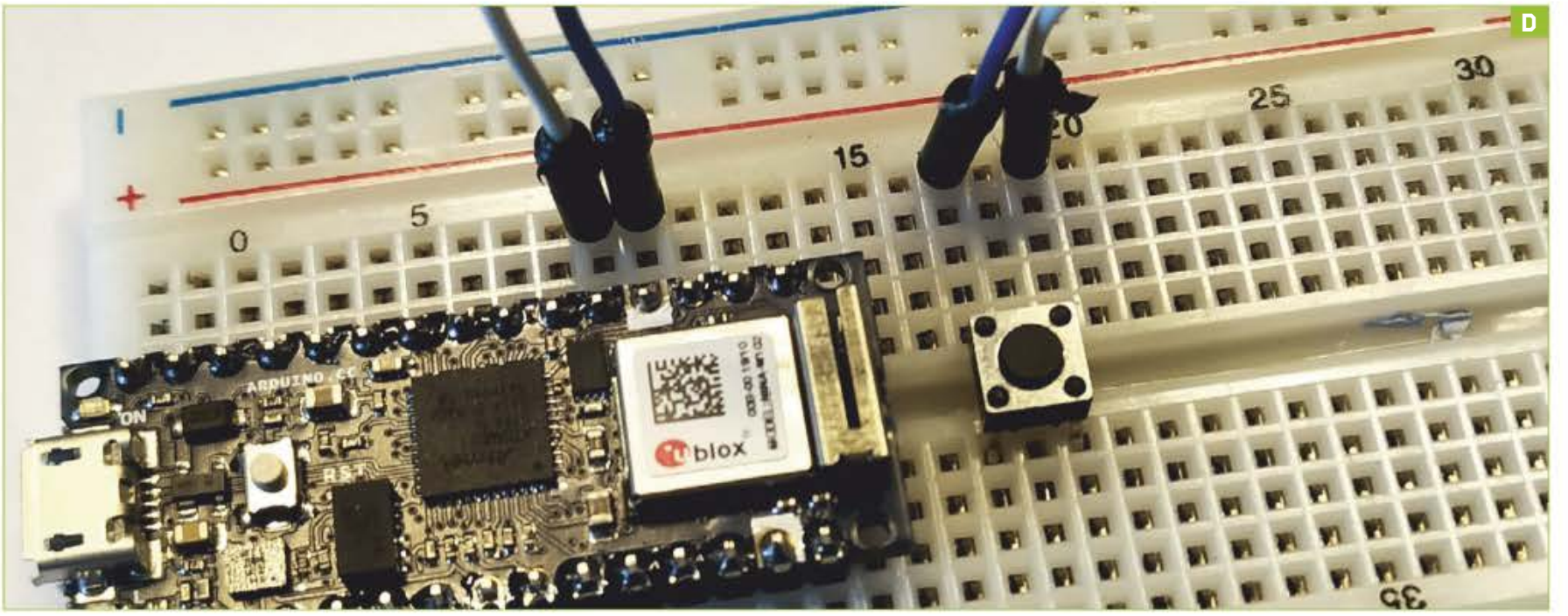
» To light up the LED we need to use "digitalWrite" and then pass the pin number and the state of the pin. In this case we set pin 2 to "HIGH," which will cause the LED to light up. After a short, 100ms delay, we then turn on the LED using "LOW". Another delay occurs before the `for` loop goes back to the start again. Once the `for` loop has run three times, it will end and break out. A final delay of one second (1000ms) will then cause the LED to be off, and it will create a long pause in the flashing sequence.

```
   digitalWrite(2, HIGH);
   delay(100);
   digitalWrite(2, LOW);
   delay(100);
  }
  delay(1000);
}
```

» Click the tick icon to check your code [**Image B**], then click on the arrow to flash the code to the Arduino. In a few seconds the board will reboot, and the LED will




© ARDUINO




quickly flash three times, then pause, and repeat the process. Congratulations! You have successfully tested your Arduino.

## 3 PROJECT 2: JOB SAVER

Here we'll build a simple switch that when pressed will trigger a new tab to open in Firefox or Chrome, opening a page that looks like MS Outlook but is really Reddit in disguise. It's handy for work, school, or home, but do so at your own risk!

›› Using a breadboard, we need to connect a push button (momentary switch) over the central channel so that the legs are spread over the gap. Now, using two male-to-male jumper wires, connect the top-left leg of the button to GND on the Arduino, then connect the top-right leg to pin 2 of the Arduino.

## 4 CODING THE PROJECT

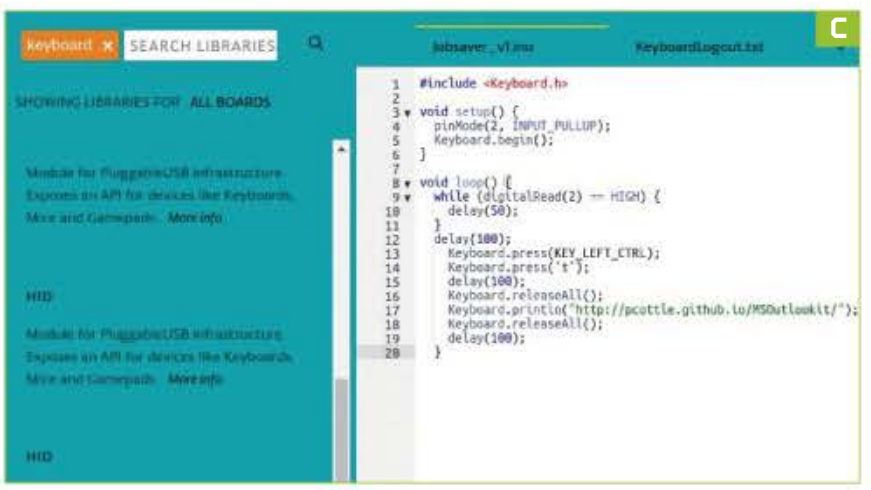
In the Arduino IoT Cloud, click "Arduino Web Editor" and connect the Arduino to your computer. Create a new sketch in "Sketchbook". Now, import the "Keyboard" library that will enable our Arduino to emulate a USB keyboard [**Image C**].

```
#include <Keyboard.h>
```

We can type this into the code, or we can go to "Libraries", then search for "Keyboard" and click "Include".

›› The next step is to configure the pin used for the button, and to start the keyboard interface. For this we will use a function called "setup", which will run once when the board is powered up. Using "pinMode", we can tell the Arduino that we wish to use pin 2 as an input, and that the internal pull-up resistor should pull the pin high so that when the button is pressed it connects pin 2 (high) to GND. This will pull pin 2 low and trigger the event.

```
void setup() {
 pinMode(2, INPUT_PULLUP);
 Keyboard.begin();
}
```




›› To continually run our code, we need to create a loop that will contain the code. The first section of code in the loop is a test to see if the button has been pressed. Using "digitalRead" we can check pin 2, and if the pin is "HIGH", the button has not been pressed. This means the code should take no action and keep waiting for input. We should use a 50ms delay to prevent accidental activation.

```
void loop() {
 while (digitalRead(2) == HIGH) {
  delay(50);
}
```

›› What happens if the button is pressed? In this case a delay is used to add 100ms delay, before pressing a series of keys to open a tab. To press a key, we use "Keyboard.press" and pass the details of the key. For keys such as Ctrl, Alt, Shift provide the details in a set manner, including whether it is the left or right of each key. For regular character keys (letters, numbers, punctuation) we pass the key as a string. We then set a 100ms delay to ensure that the keypresses are registered.

```
 delay(100);
  Keyboard.press(KEY_LEFT_CTRL);
  Keyboard.press('t');
  delay(100);
```

›› Right now the keys are pressed down, and if left too long this could cause issues. So to release the keys we use "Keyboard.releaseAll" before moving on. When a new tab is opened in Firefox/Chrome, the focus of the cursor will be in the address bar, and in the next line of code we'll paste in a URL for the Reddit/Outlook website. We then release the keys once again, before a final 100ms delay ends the loop.

```
  Keyboard.releaseAll();
  Keyboard.println("http://pcottle.github.io/
MSOutlookit/");
  Keyboard.releaseAll();
  delay(100);
}
```

›› Click on the tick icon to check your code, and then click on the arrow to flash the code to the Arduino. In a few seconds the board will reboot and be ready for use. So go ahead, press the button [**Image D**] and make sure that it works before the boss walks in!

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# REVIEWS

TESTED. REVIEWED. VERDICTIZED.

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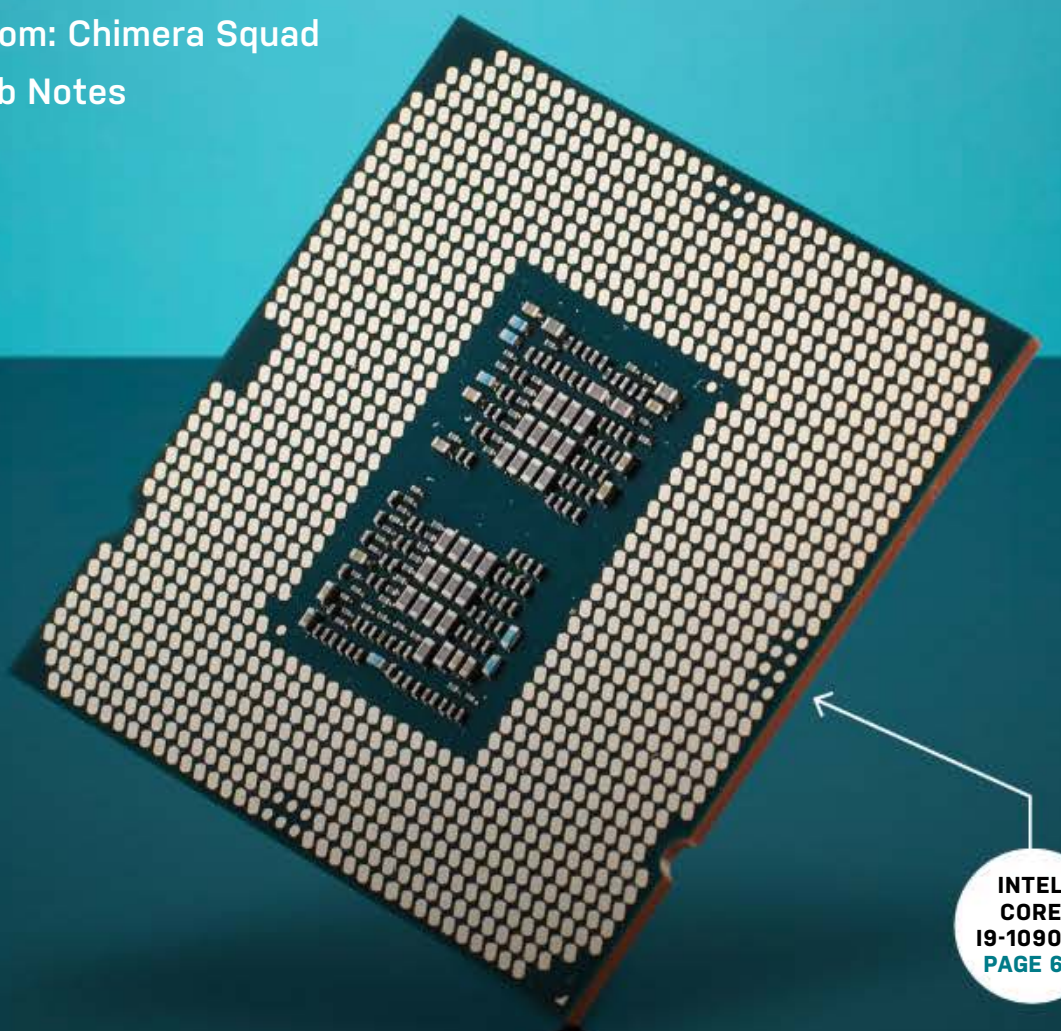

INTEL CORE I9-10900K
PAGE 68

14nm+++++ or something like that.... Probably.

# Intel Core i9-10900K

## It's another refresh, but it's still one heck of a chip

IT SEEMS WE'RE long past the days of monolithic chip designs—it's all about providing a modular solution by carefully weaving core complexes together, and having different transistor sizes across different components. That way you create a processor that not only provides impressive performance but is also affordable and simple to mass produce.

This is where Intel has come unstuck in the great core war, as its monolithic designs are far harder to produce, especially to add more cores to. To get around the loss in overall number of cores and lack of a die shrink, the company has been aggressively targeting clock speed to bolster its multi-core performance and hold on to the single-core IPC and gaming crown its held for so long.

Intel's 10th generation of processors is aptly named Cannon Lake, as its core architecture is not too dissimilar from that of its great-grandfather, Sky Lake. The company's made some significant changes not only to how it manufactures its chips, but also on a hard-encoded software level too. This time around Intel's introduced its new Turbo Boost Max Technology 3.0. The chip itself will identify which cores perform best, and then increase clock speed on those individual cores—up to 5.2 GHz on the Core i9-10900K—to improve performance in single and dual-core applications. What's impressive about this is that the chip doesn't increase the voltage to do it. On top of that it also has its Thermal Velocity Boost tech. If temperatures and voltages are within certain parameters, the processor will push that clock speed further, increasing a single core to 5.3 GHz, or all cores up to 4.9 GHz at stock.

When Intel first reacted to AMD's Ryzen processors, the simple answer was to add more cores. That in turn required more power and produced more heat. To continue that rising clock speed trend, Intel has introduced a "Thin Die STIM." The CPU die itself is far thinner compared to previous generations, allowing Intel to use a thicker soldered heat-spreader across a wider surface to remove heat more efficiently.

On top of that it's also packed in hyper-threading across the entire range—from the i3 up to the i9—improved native DDR4 support up to 2933 MT/s, included WiFi 6 AX and 2.5G Ethernet as standard, and of course introduced a new chipset, which supports up to 40 PCIe 3.0 lanes.

In the case of the flagship Core i9-10900K, all this comes together to produce a heck of a processor. In our testing we saw single-core Cinebench R15 figures up at 228, multi-core at 2,608, and an incredible Tech ARP x264 score of 54.64 fps. Now don't get us wrong, this thing is a hot chip, and it is incredibly power-hungry too. Intel rates the Core i9-10900K with a TDP of 125W. Under load our sample was pulling 301W from the wall, and reaching a temperature of 85 C with a 280mm Corsair H115i AIO.

From an engineering perspective, these chips are nothing short of impressive. However, it's still missing the mark in a few key areas. Although Z490 motherboards have support for PCIe 4.0, that's not supported on 10th gen (which could be a deal-breaker for those future-proofing for next-gen GPUs and storage). The temperatures and power-draw for the flagship are incredibly high, and right now you can pick up the Ryzen 9 3900X, 12-core processor from AMD with a cooler for almost $100 less than the 10900K. It's a tough one. On paper the Core i9-10900K is an impressive part, but in the real world, it's tricky to justify unless you're happy to upgrade further down the line, perhaps within a year or two. On top of that, with such strong multi-core performance, it's starting to encroach on Intel's own HEDT offerings.

If Intel's past is anything to go by, once it breaks that 10nm barrier, with an architecture as refined as this, we should be looking at one hell of a processor—we're just not quite there yet. **–ZAK STOREY**

### BENCHMARKS

| | Intel Core i9-10900K | Intel Core i9-9900K |
|---|---|---|
| Cinebench R15 Single (Index) | **228** | 214 |
| Cinebench R15 Multi (Index) | **2,608** | 1,994 |
| Tech ARP's X264 (avg fps) | **54.64** | 42.69 |
| Fry Render (m:s) | **1:23** | 1:49 |
| Power Draw Idle/Load (W) | 67/301 | **65/185** |
| Total War: Warhammer II (fps) | 81 | **84** |
| Ghost Recon Wildlands (fps) | 59 | **62** |
| Maximum Overclock (GHz@V) | **5.3 @ 1.36V** | 5.0 @ auto |

Best scores in bold. Our test bed consists of an MSI MEG Z490 Ace, 32GB of Corsair Vengeance RGB Pro DDR4 @ 3200, and an Nvidia GeForce GTX 1080. All games were tested at 1080p on the highest graphical profile, with average fps noted.

VERDICT **8**

**Intel Core i9-10900K**

**DECADENT** Incredible performance, good overclocking, engineering refinement.

**DECIMATED** Pricey, hot, power-hungry.

$530 www.intel.com

### SPECIFICATIONS

| | |
|---|---|
| Cores / Threads | 10 / 20 |
| Base / Turbo Clock | 3.7 / 5.3 GHz |
| Architecture | Cannon Lake |
| Lithography | 14nm++ |
| Memory Support | Dual channel @ 2933 MHz |
| PCIe Support | x16 PCIe 3.0 |
| Integrated Graphics | Intel UHD Graphics 630 |
| TDP | 125 W |

# Asus ROG Zephyrus G14

## The new crown prince of 14-inch gaming laptops

**WE HAVEN'T SEEN** a compact gaming laptop with this level of power for a while. 13 and 14-inch laptops built with gaming in mind seemed to be becoming a thing of the past, paving the way for two extremes; beefy gaming rigs with desktop-scale GPUs, and super-thin notebooks running on upgraded integrated graphics. Gaming laptops with a thin form factor are largely compelled to use of lower-power GPUs, like the respectable GTX 1650.

Not the Zephyrus G14, though. Here, we've got the slender Max-Q model of the RTX 2060 6GB, joined by AMD's shiny new Ryzen 4900HS CPU, the current pinnacle of the mobile Ryzen processor line (although we wouldn't be surprised if a 4950 arrived at some point). The 14-inch QHD screen means that the overall chassis is very compact and lightweight, so it's easy to fit in a bag when you're out and about. An ergonomic hinge tilts the keyboard toward you when you open the laptop up, making for a more comfortable typing angle and creating space underneath for air to be vented out.

The Ryzen 9 4900HS in our model is a powerful chip, easily capable of chewing through demanding CPU workloads at speed thanks to its eight cores and 4.3GHz boost clock. AMD's auto-overclocking works better than ever here, keeping CPU performance at peak levels whenever possible. It seems that Intel may still have the edge when it comes to CPU-bound games, though. Our model comes with 16GB of high-speed RAM, although a 32GB version is also available.

The GeForce RTX 2060 Max-Q in our review unit is a smidge less powerful than an ordinary desktop model of the 2060, but the smaller design enables the G14 to remain compact. It powers through most games at 1080p, with the graphical oomph to handle some titles all the way up at 1440p max settings. Ray-tracing is available here but is not really viable; the hit to frame rate isn't worth the improved lighting and reflections. Even without RTX on, though, the games we tested looked fantastic on the 14-inch display.

Let's talk about that screen. It's a 1440p IPS panel, validated by Pantone, with good color density and brightness. The big downside here is that it's only a 60Hz display, which is fundamentally not enough for skilled gamers who favor twitch shooters and racing games. An alternate model of the G14 comes with a 1080p 120Hz display, but if you want the improved resolution you've got to accept the loss with the refresh rate.

One part of the G14 that's surprising is the quality of the quad-chamber speaker setup. A symmetrical layout of two main speakers and two tweeters means that this tiny gaming laptop can pump out clear sound that's on a level with far larger systems. In stark contrast to the speakers, the webcam is, uh, non-existent. Yep, there's no webcam here, although the G14 does have a simple microphone setup for calls and recording.

That compact chassis is beautiful to behold, and the build quality is a cut above previous Zephyrus models. The body is mostly composed of aluminum alloy and feels extremely robust when picked up. We were initially intrigued by the new thermal venting design seen on this Zephyrus; twin fans pump hot air out of the system through a three-way split channel that vents heat from the top, bottom, and sides of the chassis, away from the screen. However, it doesn't seem to quite be enough. The Zephyrus G14 got very hot during testing, especially when we ran games at 1440p, to the point where the fans were working flat out to keep the system from overheating. The noise isn't too bad, but we'd be wary of gaming on this laptop for extended periods. Adjusting the power profiles in the ROG Armory Crate software helped a little, but at the cost of performance.

For all this criticism, we actually really like the G14. It's a sleek little number, packing impressive graphical oomph into a tiny casing—perfect for the gamer who is often on the move. It's not cheap, but we challenge you to find a smaller laptop that can match it for performance. Our review model doesn't include the "AniMe Matrix" of over 1,000 tiny LEDs on the back of the screen, but that's a gimmick at best. Even without it, this is a solid effort from Asus; we hope it spurs on some equally compact competition from other manufacturers.

**–CHRISTIAN GUYTON**

**VERDICT 8**

**Asus ROG Zephyrus G14**

**REPUBLIC** Solid all-round performance; excellent compact design; impressive sound quality.

**DICTATORSHIP** Gets seriously hot; screen is only 60Hz.

$1,600, www.asus.com

### BENCHMARKS

| | ZERO-POINT | |
|---|---|---|
| Cinebench R15 Multi (Index) | 1,030 | **1,846** (79%) |
| CrystalDisk QD32 Sequential Read (MB/s) | **3,374** | 1,743 (-48%) |
| CrystalDisk QD32 Sequential Write (MB/s) | **2,530** | 1,795 (-29%) |
| 3DMark: Fire Strike (Index) | 13,610 | **14,238** (5%) |
| Rise of the Tomb Raider (fps) | 92 | **96** (4%) |
| Total War: Warhammer II (fps) | **62** | **62** (0%) |
| Tom Clancy's Ghost Recon: Wildlands (fps) | 49 | **50** (2%) |

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Best scores in bold. Our gaming laptop zero-point is the Acer Predator Triton 500, with an Intel Core i7-8750H, Nvidia GeForce RTX 2060 Max-Q, and 16GB of DDR4-2666. All game tests are performed at 1080p at the highest graphical profile.

### SPECIFICATIONS

| | |
|---|---|
| CPU | Ryzen 9 4900HS |
| Graphics | Nvidia GeForce RTX 2060 6GB Max-Q |
| RAM | 16GB DDR4-3200 |
| Screen | 14-inch IPS 1440p screen @ 60Hz w/ 100% sRGB |
| Storage | 1TB M.2 NVMe SSD |
| Ports | 1x USB 3.2 Gen 2 Type-C, 1x USB 3.2 Gen 2 Type-C, 2x USB 3.2 Gen 1 Type-A, 1x HDMI 2.0b, 1 x 3.5mm audio jack |
| Connectivity | Wi-Fi 6, Bluetooth 5.0 |
| Weight | 3.53 lbs |

The G14's keyboard is softly backlit in white.

# MSI Optix MAG321CURV

## A budget 4K gaming panel?

**WE'RE HERE**, we've finally made it. It's taken a few years, but at last we're at the point in our technological lives where 4K gaming is not only feasible, but also affordable. Well, if you ignore the graphics card cost. Here we have MSI's Optix MAG321CURV. This large and impressive 32-inch 4K gaming monitor comes packed with a curved VA panel, a 60Hz refresh rate, FreeSync as standard, and a 1ms G2G response time. That's a lot of spec, especially as it comes in at just under $450 at retail. In fact at the time of writing it's currently on sale for $390 at Amazon. Go back three years, and this thing would've been over twice that price.

So before we head into reviewing this screen, the question has to be asked: Is it viable to game at 4K today? Well, sort of. If you're after that 60fps sweet spot, you're looking at a minimum of an Nvidia RTX 2080 in your build. You can get away with less than that (the 2070 Super is a fine card, averaging around the 40fps mark in most AAA titles), especially in lower fidelity titles and indie games, but for the AAA big boys, you're going to be needing to drop the graphical settings if you do decide to go that route instead.

So how's the screen? It's around what you'd expect for a monitor at this price-point. It's got a VA panel at its heart, but it's lackluster compared to some of the other IPS and VA screens we have in the office. Admittedly, its comparisons here are both artworker-certified $1000+ monitors, but nonetheless the technology at the base of these designs is effectively the same, so color performance should be somewhat similar. That's unfortunate, as VA is meant to be particularly good at dealing with dark blacks and contrast. With the MSI MAG321CURV this is actually the one area where we felt it struggled most. There was some inconsistency with the deeper blacks in particular, seeming washed out compared to some of the other offerings. Now that's to be expected to a degree, as this is a fairly affordable 4K gaming monitor, and it also comes with a hefty chunk of overdrive to enable that 1ms response time, so to expect absolute color perfection would be unfair.

Outside of the darker tones, the MAG321CURV performed well. Brighter colors really popped, and on the whole it was an enjoyable experience, far superior to some of the 4K TN panels we've seen recently—many of which come in at the same price. There was some ghosting, but after a while it was barely noticeable, and the pixel density made for a good experience for desktop and everyday use.

As for physical features, the stand is robust and easy to put together (requiring four screws to mount the monitor to an arm, then an additional base, secured by notches and a single screw). It can tilt and you can adjust its height, but don't expect full pivot or swivel here. One thing we also don't quite get is the inclusion of that RGB in the back of the monitor. It's such a fire-and-forget thing. It makes sense at a LAN party, maybe, to show off your epeen, but otherwise it serves no purpose. It's not bright enough to illuminate the wall behind, and after playing with it for five minutes you'll get bored and forget it.

So we've got a mixed bag here. It's not the perfect VA panel: It struggles a bit at the lower-end of the spectrum—though you will get used to it over time—but it throws up some foibles if you're looking at this from a professional perspective. That said, it is an exceptionally nice entry-level 4K gaming and entertainment monitor. It's very good for media enjoyment, and that pricing makes it a solid choice for the future. **–ZAK STOREY**

VERDICT **8**

**MSI Optix MAG321CURV**

**OPTOMETRIST** Affordable(ish), great pixel density, colors really pop.

**OPTICAL ILLUSION** Darker tones struggle; RGB lackluster.

$390, www.msi.com

### SPECIFICATIONS

| | |
|---|---|
| **Resolution** | 3840 x 2160 |
| **Pixel Density** | 138 PPI |
| **Panel Type** | 32-inch VA |
| **Maximum Refresh** | 60Hz |
| **Contrast Ratio** | 3000:1 |
| **Response** | 1ms G2G |
| **Display Inputs** | 1x DisplayPort 1.2,<br>2x HDMI 2.0,<br>1x USB 3.1 Type C |
| **VESA Mount** | 100 x 100 |
| **Warranty** | 2 years |

We're so close to 4K gaming. If only GPUs were cheaper.

# MAXIMUM PC DIGITAL EDITION

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# Whirlwind FX Element

## Elementary, my dear Watson

**A FULL-SIZE MECHANICAL** gaming keyboard with addressable RGB lighting on a per-key basis, for just a hundred bucks? We were immediately intrigued by the Element, with its promise of high-quality construction and performance, as well as super-immersive lighting that could react dynamically to what happens on screen. It's an enticing prospect, but we've been burned before, so we approached it with a grain of salt in hand.

Since this is the first Whirlwind FX product we've reviewed in *Maximum PC*, let's take a brief look at the company that brought us the Element. Whirlwind FX is an American company dedicated to improving PC gaming immersion, first releasing the Vortx, a strange little box that produces wind and heat in response to pre-coded actions in any game. The Element keyboard is a more conventional approach to PC hardware for the brand, but that dedication to immersion is definitely still present.

The RGB lighting under each of the Element's durable plastic keycaps is impressively bright and colorful, with a number of preset idle animations downloadable via the Whirlwind Engine software. The clarity and rainbow color gradient that this keyboard can achieve in lighting easily matches that of far more expensive keyboards from Razer and Steelseries. The interesting part, though, is how the Element's lighting can react in real time to games and other media.

In its default state, the Element will break the display into an invisible grid that corresponds to each LED on the keyboard, and continuously replicate (with no noticeable latency) the color in each grid square. This looks great in some games—the keyboard's edges flaring red as you take heavy damage in *Overwatch* is undeniably cool—but this isn't the first keyboard to do that. The Element's unique ability here is to enable gamers to code their own response patterns to the action happening on screen in any game; with the right know-how, there's no limits here.

It's not a simple process, mind you. Creating your own custom lighting schemes is done through a combination of HTML5 and Javascript, so you will need at least some coding knowledge to make it work, but resources to learn those skills are widely available. Once your script is ready, you can chuck it in Whirlwind Engine's files and it'll pop up in the app for you to use. At the time of writing, there's only a few pre-made lighting modes available for specific games, such as *Fortnite* and *Call of Duty: Warzone*, but users can create and share their own custom modes on the platform.

### SWITCH ME ON

In practice, it's very cool. Playing *Warzone* with the Element's lighting fully synced makes the keyboard pulse in alarm when you run low on ammo, and slowly illuminates green when I stop to heal my wounds. The lighting profile engages instantly when you load up the game; no tinkering needed. But fancy lighting can only carry a keyboard so far, so how does the Element feel to use?

The key switches hold the secret to the Element's relatively low price. These aren't the Cherry MX switches you'll see on pricier keyboards, but cheaper switches from Kailh instead, available in Red Linear or Blue Clicky models (we're reviewing the Red version). They're good for gaming, with a 1.7mm actuation distance that doesn't require too much force to register input. They're great for gaming, but fast typists might not enjoy the travel time feedback.

The Kailh switches won't last as long as high-end Cherry or proprietary switches, but they're durable enough, and many gamers won't notice the difference. They are a bit loud, too, but are definitely not the worst we've heard. The rest of the keyboard assembly is as solid as promised, with an upper plate of brushed aluminum and thick rubber feet to keep it from moving during use.

The real failure of the Element is its lack of dedicated media control buttons, or a scroll wheel for volume and brightness. The function keys can be used as hotkeys for this, but it's not ideal. The Element also doesn't come with a wrist rest, although Whirlwind FX was kind enough to send us one of its own $25 padded rests, which was extremely soft and comfortable—a worthy purchase even for use with a different keyboard.

For $100, we'd say that the Element is very well-priced and comes with plenty of great features. If you're big on funky synchronized lighting, this is a must-have; even if you're only mildly enthusiastic, it's still a great choice of keyboard. The keyboard as a whole is well made, and the sheer potential of the lighting options is incredible, so it's comfortably worth the asking price.

**–CHRISTIAN GUYTON**

VERDICT **8**

**Whirlwind FX Element**

**TORNADO** Good value for money; RGB lighting has huge potential; high overall build quality.

**BREEZE** Key switches aren't the best for typing; no dedicated media controls; lighting profiles demand some coding skill.

$100, www.whirlwindfx.com

**SPECIFICATIONS**

| | |
|---|---|
| **Switch Type** | Kailh Linear Red mechanical switch |
| **Switch Durability** | 70 million presses |
| **Media Keys** | Integrated w/ function keys |
| **Connection** | Single USB 2.0 |
| **Battery Life** | N/A |
| **Wrist-rest** | N/A |
| **Dimensions** | 5.4 x 17.5 x 1.4 inches |

# Steelseries Rival 3

## Take a good thing, make it cheaper

**STEELSERIES'S RIVAL LINE** of gaming mice is a dependable set of products, bringing solid performance and vivid RGB lighting with full software control in durable casings. The product line previously started at $60 with the now-discontinued Rival 300, while further iterations, such as the 600 and 710, offered more features in exchange for more cash. Steelseries has dropped the zeros for this new model, perhaps indicating the newly wallet-friendly price point.

The Rival 3 retails at just $30, an absolute steal even just considering the sensor being used here. Although the sensor inside the Rival 3 is just an adapted mid-range Pixart model, it's virtually impossible to find a cheaper mouse that can match the 8,500 maximum CPI. The sensitivity is a clear step below the rest of the Rival range, but it's a fair compromise given the price.

At first glance, the Rival 3 could be an ambidextrous mouse, but despite the symmetrical design there are only two additional buttons on one side of the mouse. It actually has more in common with the $60 Rival 310, sharing a button setup and the same matte plastic casing, but the Rival 3 has a smaller, ergonomic chassis. The soft matte black finish is comfortable and grippy, and Steelseries assures customers that the casing is durable enough to last for years.

This promise of longevity extends to the buttons, too, with a firm rubberized scroll wheel and Steelseries's own mechanical switches, rated for 60 million clicks. To put that in real-world terms, that's a lifespan of nearly three years based on average mouse usage. In practice, the buttons feel resilient, easily matching the physical click feedback of mice twice this Rival's price (try saying that five times fast).

That ABS plastic might be durable, but it's also lightweight. The mouse—not including the non-detachable cable—only weighs 2.7 ounces, and the generous lift-off distance makes using it a breeze. The only part of the Rival 3 that doesn't feel like it'll last for ages is the rubber-coated USB power cable, although finding a $30 mouse with a high-quality braided cable is a fool's errand.

The "TrueMove Core" sensor isn't anything to write home about, but it gets the job done. Everyday computer use is snappy and responsive, and the sensitivity is perfectly adequate for first-person shooters and MOBAs. DPI adjustment is handled by a dedicated button behind the scroll wheel, and while it defaults to just two modes, the Steelseries Engine software can be used to save up to five custom configurations directly onto the Rival 3's on-board memory.

### A MOUSE ON A DIET

The Steelseries Engine software also allows for RGB lighting control; the Rival 3 packs three separate RGB zones, the LEDs of which are surprisingly bright. A strip of light runs around almost the entire lower edge of the mouse, colors spilling out from underneath your hand even when the illuminated Steelseries logo is obscured. The lighting incorporates well into the overall design; simple but appealing.

While the Rival 3's smooth domed shape is comfortable under the palm, and it glides across mousepads on three wide feet, we can't help but think that this mouse might be a little too ergonomic for its own good; so much bloat has been eradicated that the Rival 3 is actually quite small, and extended use might pose problems for those who are gifted in the hand-size department. Left-handed people are also out of luck.

If that doesn't bother you (maybe you have small hands?), the Rival 3 is a strong contender in the budget gaming mouse arena. Representation from the other heavy-hitting brands is quite feeble at the $30 mark, with a smattering of individual offerings from the likes of Corsair and Cooler Master drowning in the endless flood of cheap knock-offs and unheard-of brands. If you don't want to spend too much on peripherals, the Rival 3 is a decent choice; far from top-of-the-line, but reliable and excellent value for money. –CHRISTIAN GUYTON

VERDICT **7**

**Steelseries Rival 3**

**FRIENDLY RIVAL** Amazing value; robust construction and buttons; super lightweight.

**MORTAL ENEMY** On the small side; sensor is just average; not for lefties.

$30, steelseries.com

**SPECIFICATIONS**

| | |
|---|---|
| **Sensor** | TrueMove Core Optical |
| **Sensitivity** | 8,500 CPI |
| **Sensor Model** | 300 IPS |
| **Polling Rate** | 1000Hz |
| **Programmable Buttons** | 6 |
| **LEDs** | 3 RGB zones |
| **Cable Length** | 6 feet |
| **Weight** | 2.7 oz |

# be quiet! Pure Base 500DX

## Evolutionary advancements

**NOW THIS IS WHAT** we're talking about be quiet! The Pure Base 500DX is a fantastic advancement on the original Pure Base 500 that was announced at Computex last year. This tech journo was lucky enough to get his hands on one to review back in 2019, and although it was an impressive case for the cash, it didn't quite hit the mark across the board. It had flaws, most notably with limited airflow, no RGB (although that's likely a plus for many of us), and a pretty lackluster front I/O. At the time, we knew be quiet! had plans to adjust some of the foibles us reviewers had with it, but the steps it's taken to rectify those faults are impressive.

So what was good about the original? Well it all came down to it being a very strong balance between price and features. A quick peek inside showcased a well-designed modern interior, complete with intelligent cable management, strong cooling mounting solutions, a full-size PSU cover, beautiful sand-blasted paint finish, hot-swappable roof filters, a tempered glass window, and a sound-dampening rear panel. It was nothing short of a pleasure to build in, and versatile enough for any mid-range system for folk not keen to drop more than $85 on a mid-tower case.

Fortunately the 500DX features an almost identical base layout to the standard 500, but with some significant improvements. You still get the full-size PSU cover, support to mount and showcase 2.5-inch drives on the interior alongside the cable-tidy bar, 3.5-inch drive support hidden under the PSU cover, and 140mm fan support everywhere. Most notably, however, be quiet! has gone on the offensive when it comes to the cooling problems we mentioned before.

Previously the Pure Base 500 only had an inch gap between the solid front panel and the front intake fans, and the only available air cutout lay in the bottom of the chassis at the base of that front panel. Now that's not always a bad thing—it mitigates noise somewhat, and in mid-range builds, as long as you don't live in Phoenix, Arizona with no air-conditioning, you're going to be OK with it thermally. But for performance nuts (ourselves included), compared to something like Corsair's iCUE 220T RGB Airflow, the Pure Base 500 was nearly four to five degrees hotter in our testing scenarios. That's not nothing, especially in a world where, GPUs and CPUs boost or lower clock speeds depending on a target temperature, even running at stock.

The DX variant addresses that by converting a vast majority of the front panel into a metal mesh to enable better airflow for those front intake fans. On top of that, as standard the DX gets three of be quiet!'s Pure Wings 2 140mm fans, improving the situation dramatically.

The company has also thrown in some fairly effective ARGB here too, with two strips lining the front panel, and one interior strip at the top of the case to illuminate the inside of your build. You can sync all of that with any motherboard that supports it, or an ARGB controller, or just configure it via the front I/O button. Speaking of which, we've seen an update here too. There's still not a lot of I/O, but you now get a USB 3.1 Type C port and a USB 3.0 Type A port, rather than the original's twin USB 3.0 ports.

Any downsides? Well it has seen a price hike—it's now $100 as standard for both the white and black variants, which is unfortunate as the original Pure Base 500 is still only $85. However, you get an extra fan, better airflow, and of course all of that extra ARGB for just $15 more. It's hard to critique the Pure Base 500DX: It's an evolutionary step forward on its predecessor, and a perfect all-round mid-range chassis for anyone looking to build in the ATX form factor. **–ZAK STOREY**

VERDICT 9 KICK ASS!

**be quiet! Pure Base 500DX**

**PROPER NOUN CAPITALIZATION** Fantastic interior layout; strong cooling support all round; great price; extensive RGB.

**BRAND'S OWN STYLE GUIDE** No gray variant (at least not yet).

$100, www.bequiet.com

### SPECIFICATIONS

| | |
|---|---|
| **Motherboard Support** | ATX, M-ATX, ITX |
| **2.5 / 3.5-inch Support** | x5 / x2 |
| **Max Radiator Support** | Front: 360mm, Top: 240mm, Rear: 140mm |
| **Fan Support** | Front: 2x 140/3x 120, Top: 2x 140/120, Rear: 1x 140/120 |
| **Dimensions** | 17.7 x 9.1 x 18.2 inches |
| **Graphics Card Clearance** | 14.5 inches |
| **CPU Tower Clearance** | 7.5 inches |

PUZZLE ADVENTURE

# In Other Waters

## Who is the bad guy here?

**FIRST-CONTACT** situations tend to go badly in sci-fi. Aliens are generally resource-hungry asset strippers, perfect killing machines, or under threat from the Borg. With intellects that are vast, cool, and unsympathetic, they draw their plans against us. Fish? Not so much.

And yet here we are. The game's setting of Gliese 677Cc is real, an exoplanet 22 light-years away that orbits within the habitable zone of its red dwarf star, itself part of a triple-star system. In Fellow Traveller's hands, it's reimagined as an ocean world teeming with life below the surface, begging to be explored.

And so you do, through the game's fantastic interface. You don't play as xenobiologist Ellery Vas directly, but as her AI companion built into her diving suit. Thanks to the abstract way in which you view the world through the suit's interface, Vas's descriptions of scenes become the primary window on the ocean. This isn't ABZÛ, where huge whales and shoals of rainbow-colored fish accompany you, it's a game of waypoints and scanners, hazardous terrain and dwindling oxygen (the only price for running out is starting a region again).

There's a plot about finding a missing fellow scientist, who hasn't been seen since she splashed down on the planet, and the resource-stripping company you both work for (oh no). But soon the joy of exploration takes over from following your friend's footsteps. And with no bad guy to defeat, the game has a restful pace, rather like an underwater holiday taken through Google Maps.

### INTERCONNECTED WORLD

You're quite hands-on as an AI companion. Vas seems unable to operate the suit herself, which seems like something of a design flaw, but that does have the benefit of freeing her to observe and catalog while you worry about mundane stuff like movement. She sets an objective for a region and leaves it up to you to complete it. Your lab acts as a hub area you return to between regions, and it's here that you analyze the samples you've collected and build a database of the planet's satisfying alien life. Gather enough information about a species and you unlock a diagram, but each plant and associated life form is only a part of the larger web of life you uncover. Everything is dependent on everything else, while some creatures turn out to be symbiotic, incapable of existing without each other—a bit like you and Vas.

The slow pace and relaxed attitude is let down by a database-completion percentage—a score that makes no sense, as to know this fraction is to already know the whole, which is what you're trying to discover. It's a small irk and easily forgotten once you immerse yourself in the bright colors and atmospheric score. The frustration that you must see all this lush life second-hand through Vas's descriptions threatens to set in, but this isn't a game about exploring on your own, it's about being part of a team. Your input is just as important as Vas's, and this relationship is as much part of the game as the strange ocean you inhabit.

Simple on the surface and stylish all the way down, this is an ideal game for our less-than-perfect times. **–IAN EVENDEN**

VERDICT **8**

**In Other Waters**

**SPLASH** Relaxing abstract exploration with peaceful score and an alien ocean.

**CLASH** Scoring feels wrong, the need to see things with our own eyes is strong.

**RECOMMENDED SPECS** CPU, 64bit, 2GHz. RAM, 4GB. GPU, 2GB VRAM.

$15, fellowtraveller.games, Not rated

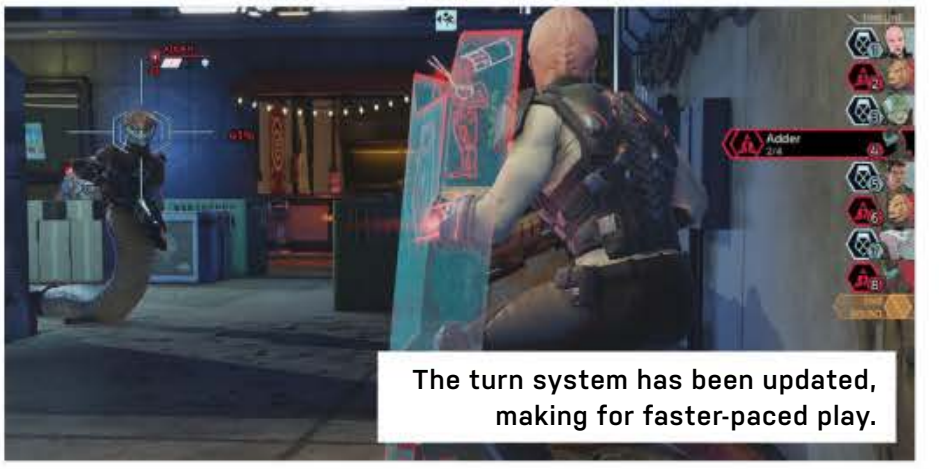
© FELLOW TRAVELLER

Ready-made soldiers replace the user-generated ones of previous games.

TURN-BASED STRATEGY

Your squad is comprised of humans and aliens.

Keep City 31's districts from boiling over into revolt.




The turn system has been updated, making for faster-paced play.

# XCOM: Chimera Squad

## Say hi to the hybrids

**UNEXPECTED TURN-BASED** tactics games are clearly the in thing right now, following last month's out-of-nowhere *Corruption 2029* (and hopefully we'll have the really unexpected and slightly mind-blowing *Gears Tactics* next issue too). *Chimera Squad* isn't *XCOM 3*, it's a side story set after the events of the previous game that revolves around breach-and-clear operations against those who would continue the alien war from both sides.

Following the withdrawal of the Elders and the Advent forces, plenty of aliens and alien/human hybrids have been left behind. The peace between them is fragile, and best defended by crashing through windows and doors before diving behind cover and opening fire. *Chimera Squad* is classic *XCOM*, but shaken up in the way only winning a war against an alien oppressor can.

Moves are now interleaved—you move one of your troops, the opposition moves one of theirs—instead of moving your entire squad at once. This has huge effects on the flow of play, as you're never put in a situation where a misjudgment on your turn means you're completely wiped out on the bad guys' turn. There's always a chance to rescue things, to reposition an overwatching gunner to catch a troublesome enemy out on its next move. Of course, 90-percent shots can still miss, grenade throws can go awry, and creative chaos still reigns, but the game feels faster. This, combined with the smaller maps, makes for a frantic scramble toward objectives. The action starts as soon as you hit the "Breach" button.

Tactical changes include the new breach phase, in which you're encouraged to eliminate high-value enemies with little damage to your squad, but the strategic arc has had an overhaul too. Base building has been removed from the game, replaced with a new strategy layer in which you monitor the City 31 setting for "tension", never letting one district boil over into revolt. Missions are the usual spread between resource-grabs and those that actually advance the story, and time is also a factor. You never have quite enough to maintain the low-tension ideal, forcing your squad into action to calm things down.

The squad is different this time around too, with ready-made characters replacing the user-definable soldiers of old. Some fought for the aliens during the war, others on the human side. That goes down about as well as you'd expect. Soldiers can no longer die, with those left behind returned to you as "gravely wounded" and sporting scars, which equal a drop in stats. These can be removed by training, but this takes the character out of the game for a few turns and can cause a drop in your squad strength, which can lead to mission failures, the dominos falling from the butterfly's wingbeats.

And as you watch it all go wrong, two thoughts occur. That by firing ready-made scenarios at you each mission, instead of letting you take things as they come and creating your own paths, this tactical game has taken some tactical capability away. But with the new turn system, and the knowledge that a run of 50-percent shots might just come off, it hands it back in spades. **–IAN EVENDEN**

VERDICT 8

**XCOM: Chimera Squad**

**CHIMERIC** Tightly focused tactics in a city that's primed to explode.

**GENERIC** Can feel like you're not really in charge, user-generated soldiers missing.

**RECOMMENDED SPECS** CPU, 3GHz Quad Core. RAM, 4GB. GPU, GTX 980 or equivalent.

$20, xcom.com, Rated T

© 2K GAMES

# LAB NOTES

**CHRISTIAN GUYTON**, STAFF WRITER

## Freebie Folly

How long can the games industry keep giving stuff away for free?

**EVERY WEEK** I log into the Epic Store and Twitch desktop app and see what freebies are being thrown at me. It's a weird obsession, I'll admit, and I end up with more games than I'll likely ever play, but it's worth it for the occasional gem. Well, I say "occasional," but there's plenty of good stuff being given away: *Celeste*, *For Honor*, *Just Cause 4*, and more have all dropped into my lap, and that's just from Epic.

It's a strange proposition: I offer nothing in return and yet am showered with enough games to eat up all of my free time. I've only spent about $20 of my own hard-earned cash on the Epic Store, and yet I scoop up a free game or two just about every week. Sure, there's rarely anything new, but there's enough games that I missed when they first released to keep me happy.

How long can bodies like Epic keep this up? Twitch has the backing of the cash cow that is Amazon, but one imagines that Epic is hemorrhaging money. What deals are cut with developers to get their games back out onto players' machines? How much do the original developers make with each free download? One day, the pool of *Fortnite* money at Epic HQ will run dry.

**Epic handed out *Grand Theft Auto V* for free in May.**

Epic's reputation among devs is generally good, as it takes a slimmer cut of sales profits than other digital storefronts; nobody would be willing to pass up selling their games on Steam otherwise. Perhaps it's as simple as a matter of buying goodwill from developers. Epic definitely has the money to throw around right now; Twitch does too, if Jeff Bezos's ever-growing wealth is anything to go by. But even a behemoth like *Fortnite* won't last forever, and I have to question whether Epic would be better off reinvesting that money for the future.

## INDUSTRY INSIDER

There's nothing more convoluted in this industry than the humble mouse mat. Originally developed to ensure your ball mouse would glide over your desk, over the years they've got more complex to the point that you can now spend $160 on one.

How did we end up here? Well, with sensors mostly, or at least it seems that way. First the laser sensor was developed, then the optical IR sensor. Turns out they both respond differently to different materials. Lasers prefer hard mats and reflective surfaces, whereas optical does better on a cloth, matte finish. And then you have aluminum mouse pads that murder PTFE feet, and easily cleaning mouse mats, and plastic hard pads with reflective glitter in them, and it all increases the price.

And then came the RGB: Another cable cluttering the desk. But hold on, we're not quite done, Qi charging is now a thing too, and thus the $160 mouse pad is born. Yep, you can wirelessly charge your mouse on your mouse mat, so you'll never need to worry about a cable again. Except maybe the one on the mouse mat of course.

And what have we solved by doing any of this? It's an area where obsessive marketing and over-engineering has ruined what should have been a perfectly simple thing.

© GETTY IMAGES, ROCKSTAR

# WD_Black P10 Game Drive

**WITH CLOUD-BASED** storage solutions becoming more and more integrated into our digital lives, the external drive is in danger of fading into obscurity. Gone is the need for chunky backup hard drives, when we can simply punt our files off into the yawning data void that is Google Drive or Dropbox. Gone are the days when you'd need a USB flash drive to bring some files to a friend, now that wireless data transfer between devices is commonplace.

It's not just that cloud storage has become more effective and widely available, it's the flexibility it offers. In the past decade, compatibility has massively improved, to the point where we can now save a document on our PC, then open it up on a smartphone or tablet to continue working on it. It's this ease of use that has made cloud computing a success—but it can't do everything.

For low-intensity tasks like word processing or playing music, streaming directly from your cloud isn't a problem. Google Drive works near-perfectly on any suitable device, with multiple users able to edit the same document in real time, because streaming basic inputs like typing back and forth isn't difficult even on lower-end internet connections. Google's ability to pour money into its projects helps too.

But when we get to the more demanding activities you might do on your PC—in this case, gaming—simply streaming from the cloud isn't always going to work. Cloud-based gaming platforms have had a rocky history, from the now-infamous collapse of OnLive to the more contemporary issues being faced by Stadia and GeForce Now users. The fact is that while fully streamed gaming is perfectly possible, the internet infrastructure needed for the average consumer to use it isn't here yet. Google recommends a bare minimum of 35Mbps, while the national average in urbanized areas barely scrapes above that, and in rural areas is unlikely to reach it at all. In a telling move, Sony added a download function to its game-streaming subscription service PlayStation Now in 2018, allowing players to retain a local copy of the game so that the content didn't need to be streamed.

Enter the WD_Black P10 Game Drive. Western Digital's expertise when it comes to data storage isn't in question; this looks and feels like a high-quality product, with a hard plastic casing. The WD_Black range features hardware designed with gamers in mind, and the P10 is no different. It connects to your PC (or a console) via an included USB-A to USB-B Micro cable, then acts as an additional drive for you to run games from or store files on. As with most of Western Digital's hardware, it comes with a three-year warranty.

Using it couldn't be simpler; with a PC, this is as straightforward as plugging it in and downloading your games onto it. We tested several games with the P10 on a stock gaming PC, and it performed admirably throughout, with no noticeable hiccups. Load times in a few games were a tad lengthy, but we're accustomed to the blinding speeds of M.2 SSDs, so it's not really an issue. Under test conditions, our P10 hit a maximum transfer speed of 138MB/s, just below the advertised maximum of 140MB/s. It's not super-fast, but it outstrips most conventional HDDs.

The P10 comes with up to 5TB of storage capacity, with the 2TB model clocking in at $80: Cheaper than Western Digital's 2TB WD_Black internal HDD. If you're trying to game on an HDD but don't have at least $200 to splurge on a 2TB SSD, the P10's the way to go. **–CG**

$80, www.westerndigital.com

## EDITOR'S PICK

Zak Storey, **Editor**

### INTEL CORE I5-10600K

I've had a bit of an epiphany. Maybe it's because I'm sat at home all day, every day on my PC, but I'm just not sure I'm a big fan of large, hot processors anymore. For my work rig, I have a 12-core Ryzen 9 3900X, with two RTX 2080 Supers in SLI, all of which are liquid-cooled via two 360mm radiators, and chilled by six beefy EKWB Vardar fans. Now that's great, the system performs well and remains cool while it does it. My office though? It may as well be a Swedish sauna.

On top of that, I just can't justify having those extra cores anymore. I don't render, I don't stream, I don't output video. At home, I do my job, I game at 3440x1440, I browse Airbnb locations, and research the Norwegian real-estate market (don't judge me). So why do I a) have more than eight cores, and b) run two GPUs in SLI, despite the fact only 50 percent of the games I play even have profiles for them?

Yep, a new system is on the horizon for sure. I'm thinking ITX, single GPU, and a decent six to eight-core processor. With Intel's latest batch of processors finally hitting the ground, I'm curious about its latest i5-10600K. It's effectively a more efficient, more modern variant of the Core i7-8700K that launched two years back. It comes with six cores, 12 threads, and a bevy of new features, along with (of course my biggest weakness) a swathe of shiny new Z490 mobos.

Now we haven't reviewed this just yet, but if it hits all the marks just right, I'm going to have some serious thinking to do between building another liquid-cooled rig with either this, the Core i7-10700K, eight-core variant, or perhaps a Ryzen 7 3700X. Decisions, decisions.

$262, www.intel.com

# LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

## > ITX Cases
## > Not All Gamers
## > Labrador Love

### April Mini ITX Build

Christian built a mini ITX system that I wanted to build because I am retired and spend time visiting my kids around the U.S. But when I priced the mobo and the Ryzen CPU the costs have gone up dramatically. Is it because the hardware is now aged, or is it because of the COVID-19 pandemic?

If I wanted to upgrade to a later-gen Ryzen and mobo, what would you recommend, and have the costs been inflated there also?

**–Dave Earls**

**STAFF WRITER CHRISTIAN GUYTON RESPONDS:** I'm pretty sure the CPU in question was on sale when I assembled this build. For now, a decent alternative might be the Ryzen 5 3600; at the time of writing, it's available for $175 on www.newegg.com. The COVID-19 situation has impacted component availability, so we're seeing a lot of sold-out products right now, but getting a decent chip for under $200 is possible.

ITX motherboards have been hit worse, since they're typically in less demand than CPUs and as such aren't a production priority. They're now in very short supply, so I'd be inclined to simply get whatever you can. Any typical 400-series AMD board (such as the MSI B450I Gaming Plus AC) should do the trick, but bear in mind that you may need to update the BIOS to support a 3rd-gen Ryzen processor. Do your research first; some manufacturers are updating the boards prior to sale, which would be ideal if you don't have a 2nd-gen Ryzen chip lying around to update the BIOS with.

Regarding price inflation: Prices aren't so much rising across the board so much as they simply aren't dropping in the usual trend. There are fewer sales on, too. If you buy brand-new now, you shouldn't be paying an inflated price, but you likely will be paying the full price. Avoid buying second-hand right now unless you're confident it's a good deal; third-party sellers are taking advantage of stock shortages to ramp up prices, so shop with caution.

Boomer and Mattie.

### Welcome Back!

Just wanted to say that I'm glad to see Zak back at *MPC*. I always liked his columns, and to have him lead the future of this beloved magazine is even more exciting.

The icing on the cake is the main cover story of the May edition. I have been watercooling my rigs for almost a decade, but I haven't kept up with new developments in recent years. So this month's cover story couldn't be more timely, as I am starting a new build using an HTPC case.

**–Tom**

**EDITOR ZAK STOREY RESPONDS:** Thanks for the kind words, it's a pleasure to be back. I missed this place like you can't possibly imagine. I'm glad you brought this up as it's something I'm trying to find a good excuse to talk about. I'm dying to build myself a liquid-cooled ITX PC again. The Phanteks build was an awesome project, but it's got faults that I'm just not happy with—the main one being airflow (and to be honest, performance).

I have a soft spot for the ITX form factor. In fact out of the majority of non-dream machine liquid-cooled builds I've done, three out of five of them have been ITX.

For me it's the perfect form factor, and a weird sort of challenge—like sticking a 3.2L V6 engine in a front-wheel-drive Volkswagen Golf Mk2. You just don't expect such a small system to have that kind of power, and to take advantage of it so effectively. That's the appeal: Doing a dumb thing in something small.

↘ submit your questions to: comments@maximumpc.com

My problem is finding the right chassis. ITX isn't the most popular, and there's this debate among purists as to whether a case is ITX or not, so manufacturers typically lean more on the smaller size, rather than catering for liquid-cooled support. For instance a lot of folk don't consider the NZXT Manta—one of my favorite cases of all time—small form factor at all, because you can fit two 240mm rads in it. In fact, there's a fantastic mod someone did where they actually converted it to a micro ATX build instead.

That said, I've got some ideas. EKWB's been teasing me by suggesting it might give me its long EOL Vulture chassis that it still has at its HQ, which features support for a 360mm front-mounted rad and an inverted case layout (another favorite feature of mine). Antec, meanwhile, has a case called the Striker, which blurs the edges between outlandish style and open-air ITX awesomeness. Both are tempting, but it saddens me that there's not more choice for the liquid-cooling enthusiast. If I was handy with a CNC machine and CAD/CAM tech I'd love to build my own case, but that's a pipe dream.

## Labrador Love

Hello *Maximum PC*! I've been a reader for over a decade, but it's my first time as a writer. This one's for Zak. Zak, you haven't been around long, but I have really enjoyed your subjects and writing prowess! Thank you. But what got me to respond is that great chocolate lab you were smart enough to get (besides that Google Home Mini).

As you can see, your chocolate looks like my Boomer. Mine are both crate-trained, and there are many advantages, sans the Hershey squirts! About that, you cannot change foods without gradually mixing with old food—usually a week of gradually mixing in new food until they are on 100% of the new. Also, some labs need sensitive-stomach food. However, if a puppy, the first two years should be "large breed puppy food." One of my two, Mattie, needs sensitive-stomach food. Boomer will inhale anything!

I am 72 years young and cut my teeth on a Packard Bell 286 PC. My first journey into hardware was getting up the nerve and $179 to buy and install a whopping 2MB RAM stick, doubling the RAM!

That extensive experience led to me having a second career in ATMs, as they were converting from firmware to software-based. Zak, keep writing about tech and I'll keep being your lab advisor. Glad you're back! **–Bob Olson**

EDITOR ZAK STOREY RESPONDS: Hi Bob! Thanks for the email, and the advice. I know we had to cut some of it out here, but rest assured, I've taken it all on board.

Like you, I've poured hours into researching what's best for my little pupper. Inje's around one year and five months old as I type this, so she's getting up there. We've certainly discovered she can eat (we had a nasty run-in with rat poison while she stayed at a dog-lodger's when we were on vacation), but she's not got a sensitive stomach fortunately. She shares half my lunch most days, and has a fondness for apples and carrots—the latter of which we use to clean her teeth, and as a treat. That was mostly because the vet complained that the chews we were giving her were making her fat.

That particular poop session was caused by a stomach bug that seemed to be going around a lot of the dogs in my area. We think she picked it up from going on a walk and eating another dog's poop.... The vet popped her on some antibiotics and she was back to her usual bounding self within three days.

I can't tell you enough, though, just how fantastic she is for my mental health. I'm fairly introverted at the best of times, but I started working from home in January 2019 and quickly realized it's a lonely existence, so she keeps me company and keeps me sane. It's perhaps the best WFH tip I can give anyone: Buy a dog, they're great company. Oh and get out of the house once a day, even if it's just to go to a coffee shop,or pick up some groceries.

Also, the Packard Bell 286 is similar to the first PC I ever used in elementary school!

## We're Not All Gamers

Gentlemen, I subscribe to *Maximum PC* and enjoy a majority of the articles. But I am not a gamer. If you judge that I belong to a significant minority of your readers, please consider devoting a set of Build Its to top-quality machines well-suited to a range of systems, spanning a budget build for simple home use to a high-end, versatile, robust system suited to a thriving small business.

If inclusion of build instructions for the latter unit is not deemed worthwhile, perhaps you could direct your readers to resources that would assist in that regard. With any luck your knowledgeable staff might find responding to this request a novel challenge and address it with gusto! **–G Stevens**

EDITOR ZAK STOREY RESPONDS: This is a very good point. Now, obviously myself and Christian are big into gaming—it's what drew us to this passion of ours—so naturally it's bound to eek across into what we build and how we write.

However, I'm trying to take care of some of the balancing issues in *Maximum PC* as a whole, and I totally agree with you. We haven't been doing enough to address all of our audience, and that's something I'm looking to rectify. Going forward, our intention is to produce two builds an issue. Next month, for example, I'm working on an Intel Cannon Lake gaming PC, and on the flip side Christian's building a noise-optimized audio-recording studio build, with a GTX 1650.

And this issue we have that home office PC with 16GB of DDR4 and a 1TB PCIe SSD, all for just $535, which genuinely blows me away.

**[NOW ONLINE]**

## HOW TO USE WINDOWS 10'S FOCUS ASSIST

If you're working from home, you might be concerned as to how you'll be able to focus in your new working environment. For Windows 10 users, though, there's an often-overlooked feature called Focus Assist that can come to the rescue.

Flick a switch and you'll banish notifications, alerts, and more from pestering you when you need to stay on track; use it effectively and it becomes your secret weapon against distractions. Just follow the tips in our guide to master this handy feature as we show you how to use Focus Assist.

Read the full article here: https://bit.ly/2AOLNCe

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# THE BUILDS

## BUDGET

**WELCOME TO THE NEW-AND-IMPROVED** *Maximum PC* Blueprints! We're happy to announce that we're shaking things up in this section, and from now on we'll be including both an Intel and an AMD build for each tier. You'll also notice that Upgrade of the Month is gone, but we'll still discuss the best upgrades we make.

So to kick things off, let's take a look at our new budget builds. Our AMD build has changed only a little from last month, with the big change here being the jump away from Nvidia to AMD's Radeon RX 5600 XT 6GB, specifically ASRock's Challenger D model. Now, we're not going to be sticking rigidly to only using AMD GPUs in the AMD builds each issue, but it felt appropriate this time around. This AMD machine was cheaper overall than the budget Intel build, so splashing out on the 5600 XT was an easy choice, giving it a small graphical performance edge over its Intel counterpart, which uses the GTX 1660 Super.

Motherboard pricing was tricky here. B450 boards make building budget AMD systems relatively easy, while the only sensible option for Intel is a Z300-series mobo, which is a bit pricier. Without one of these, you'll forgo the ability to overclock the Core i5-9600K processor we're using. Speaking of the processor, its performance runs close to the Ryzen 5 3600; it struggles in some areas due to its six threads (versus the 3600's 12), but it's still a very competent gaming CPU.

Overall, we'd give the lead to the AMD build this issue, but the Intel build's performance isn't to be sniffed at. The Intel system isn't so affected by memory frequency, so you should be able to save some cash by sticking at 2,400MHz, but a sweet sale on the 3,000MHz T-Force Vulcan Z memory puts the AMD build in excellent standing this month. The final key advantage of the Ryzen 5 3600 is support for PCIe 4.0 SSDs, but it's a dubious victory in the budget arena since you'll need a B550 mobo.

### AMD INGREDIENTS

| PART | | PRICE |
|---|---|---|
| Case | BitFenix Nova TG | $67 |
| PSU | EVGA 400N1 400W | $38 |
| Mobo | MSI Pro B450M | $80 |
| CPU | AMD Ryzen 5 3600 | $172 |
| GPU | ASRock Challenger D RX 5600 XT 6GB | $270 |
| RAM | 16GB (2 x 8GB) Team T-Force Vulcan Z @ 3,000MT/s | $60 |
| SSD | 120GB Adata SU650 2.5" SATA III | $30 |
| HDD | 1TB Seagate Constellation ES ST1000NM0001 HDD | $33 |
| OS | Ubuntu Desktop Linux 18.04 LTS 64-bit | $15 |

**Approximate Price: $765**

### INTEL INGREDIENTS

| PART | | PRICE |
|---|---|---|
| Case | BitFenix Nova TG | $67 |
| PSU | EVGA 400N1 400W | $38 |
| Mobo | ASRock Z390 Pro4 | $125 |
| CPU | Intel Core i5-9600K | $200 |
| GPU | Gigabyte GeForce GTX 1660 Super 6GB | $240 |
| RAM | 16GB (2 x 8GB) GeIL EVO POTENZA @ 2,400MT/s | $63 |
| SSD | 120GB Adata SU650 2.5" SATA III | $30 |
| HDD | 1TB Seagate Constellation ES ST1000NM0001 HDD | $33 |
| OS | Ubuntu Desktop Linux 18.04 LTS 64-bit | $15 |

**Approximate Price: $811**

# MID-RANGE

**WE KNOW A FEW COMPONENTS** are shared between the two builds, but don't fret—we're going to be diversifying each pair of builds further with each coming issue. You may also have noticed that we're pumping up the average power of the builds, so they'll be a bit more expensive but with an increase in performance.

Processor-wise, we've got the AMD Ryzen 7 3700X against the Intel Core i7-9700F. Opting for the F variant rather than the more expensive i7-9700K loses us integrated graphics and a small amount of overclocking headroom, but that shouldn't be a problem. The Ryzen 7 3700X is cheaper and manages to outperform the 9700F in some areas thanks to simultaneous multi-threading, but the Intel chip remains superior for gaming.

Both builds have powerful 1440p GPUs, the MSI Radeon RX 5700 and the Gigabyte GeForce RTX 2060 OC. The former has additional VRAM that affords it slightly superior performance, but the 2060 is a cheaper (and in many games, more reliable) card. The 2060 also has ray-tracing capabilities, in theory a major feather in its cap against AMD, but in reality the 2060 isn't that well equipped to handle ray tracing in most games.

The AMD system now packs a fourth-generation PCIe M.2 SSD, the Corsair Force MP600, giving it a major advantage over the Intel build in file transfer speed thanks to its 3rd-gen Ryzen chip and X570 motherboard. In practice, however, the difference is likely to go unnoticed by most. The Intel build retains the more affordable Western Digital SN750 SSD. Both systems are rocking twin-fan air coolers for their respective CPUs: The Corsair A500 for the AMD build, and the Noctua NH-U12A for the Intel one.

Elsewhere, we're pulling some components over from the budget build for now, namely the memory and hard drives. Keep an eye on these: We're watching component prices closely, and we'll be introducing some more variety very soon.

## AMD INGREDIENTS

| PART | | PRICE |
|---|---|---|
| Case | Fractal Design Meshify C | $90 |
| PSU | 600W EVGA 600 BQ | $75 |
| Mobo | Gigabyte X570 Aorus Elite | $200 |
| CPU | Ryzen 7 3700X | $295 |
| Cooler | Corsair A500 Dual Fan | $100 |
| GPU | MSI Radeon RX 5700 8GB | $330 |
| RAM | 16GB (2 x 8GB) Team T-Force Vulcan Z @ 3,000MT/s | $60 |
| SSD | 500GB Corsair Force MP600 | $120 |
| HDD | 1TB Seagate Constellation ES ST1000NM0001 HDD | $33 |
| OS | Windows 10 Home 64-bit OEM | $100 |
| **Approximate Price:** | | **$1,403** |

## INTEL INGREDIENTS

| PART | | PRICE |
|---|---|---|
| Case | Fractal Design Meshify C | $90 |
| PSU | 600W EVGA 600 BQ | $75 |
| Mobo | MSI MPG Z390 Gaming Plus | $168 |
| CPU | Intel Core i7-9700F | $330 |
| Cooler | Noctua NH-U12A | $100 |
| GPU | Gigabyte GeForce RTX 2060 OC 6GB | $310 |
| RAM | 16GB (2 x 8GB) GeIL EVO POTENZA @ 2,400MT/s | $63 |
| SSD | 500GB Western Digital WD Black SN750 M.2 PCIe SSD | $80 |
| HDD | 1TB Seagate Constellation ES ST1000NM0001 HDD | $33 |
| OS | Windows 10 Home 64-bit OEM | $100 |
| **Approximate Price:** | | **$1,349** |

**THIS ONE IS TRICKIER** to compare. It goes without saying that the Threadripper chip wipes the floor with the i9-9900K in most CPU-intensive tasks, although the Intel processor is both cheaper and often the better choice if you're gaming. It also keeps the build from getting too pricey in other areas. Cheaper, lower-speed memory is more viable than with the Threadripper 2950X, and X399 motherboards are almost universally on the steep side, while Z390 boards vary significantly in price, allowing us to pick out something good but still sensible. We've opted for the Asus TUF Z390-Plus Gaming, a high-quality board at a reasonable price, while the AMD build retains the ASRock X399 Taichi.

We've taken those savings and reinvested them, aiming to keep the price points of these two builds as close together as possible. We splashed out on a slightly more expensive RTX 2080 Super on the Intel build, going with EVGA's factory-overclocked model rather than the Gigabyte card still sitting in the AMD build. In another bold move, we're also using the excess cash to upgrade to Gigabyte's super-flashy 280mm Aorus RGB AIO cooler. Yes, it's definitely expensive for a two-fan AIO cooler, but it brings RGB-lit fans and a full-color LCD display atop the pump block, which can be customized to display live stats, such as your CPU temperature. It's a seriously cool product, and you can consider it our Upgrade of the M—no, wait, we're not doing that anymore, are we?

The Intel build keeps the RGB lighting coming with its memory: The Corsair Vengeance RGB Pro, to be precise, with 32GB of capacity and a frequency 2,666MHz. The AMD build has rainbow RAM too, but the need for higher memory speed means that the G.Skill TridentZ kit we used is more expensive. Both builds are using BarraCuda SSDs and HDDs from the ol' reliable that is Seagate, making for 7TB of storage per build. Again, watch this space, as we've got big plans. The 3rd gen of Threadrippers is finally calling, and 10-series Intel chips are knocking on the door too.

## AMD INGREDIENTS

| PART | | PRICE |
|---|---|---|
| Case | NZXT H710i | $170 |
| PSU | 850W Corsair RM850x 80+ GOLD | $160 |
| Mobo | ASRock X399 Taichi sTR4 | $320 |
| CPU | AMD Threadripper 2950X | $690 |
| Cooler | Corsair iCUE H115i RGB Pro XT 280mm | $140 |
| GPU | Gigabyte GeForce RTX 2080 Super Gaming OC White 8GB | $740 |
| RAM | 32GB (2 x 16GB) G.Skill TridentZ RGB @ 3600MT/s | $190 |
| SSD | 1TB Seagate BarraCuda 510 M.2 PCIe SSD | $169 |
| HDD | 2x 3TB Seagate BarraCuda Compute HDD | $170 |
| OS | Windows 10 Homes 64-bit OEM | $100 |
| **Approximate Price:** | | **$2,849** |

## INTEL INGREDIENTS

| PART | | PRICE |
|---|---|---|
| Case | NZXT H710i | $170 |
| PSU | 850W Corsair RM850x 80+ GOLD | $160 |
| Mobo | Asus TUF Z390-Plus Gaming | $308 |
| CPU | Intel Core i9-9900K | $530 |
| Cooler | Gigabyte Aorus RGB Liquid Cooler 280mm | $269 |
| GPU | EVGA GeForce RTX 2080 Super Black Gaming 8GB | $770 |
| RAM | 32GB (2 x 16GB) Corsair Vengeance RGB Pro @ 2,666MT/s | $158 |
| SSD | 1TB Seagate BarraCuda 510 M.2 PCIe SSD | $169 |
| HDD | 2x 3TB Seagate BarraCuda Compute HDD | $170 |
| OS | Windows 10 Homes 64-bit OEM | $100 |
| **Approximate Price:** | | **$2,804** |

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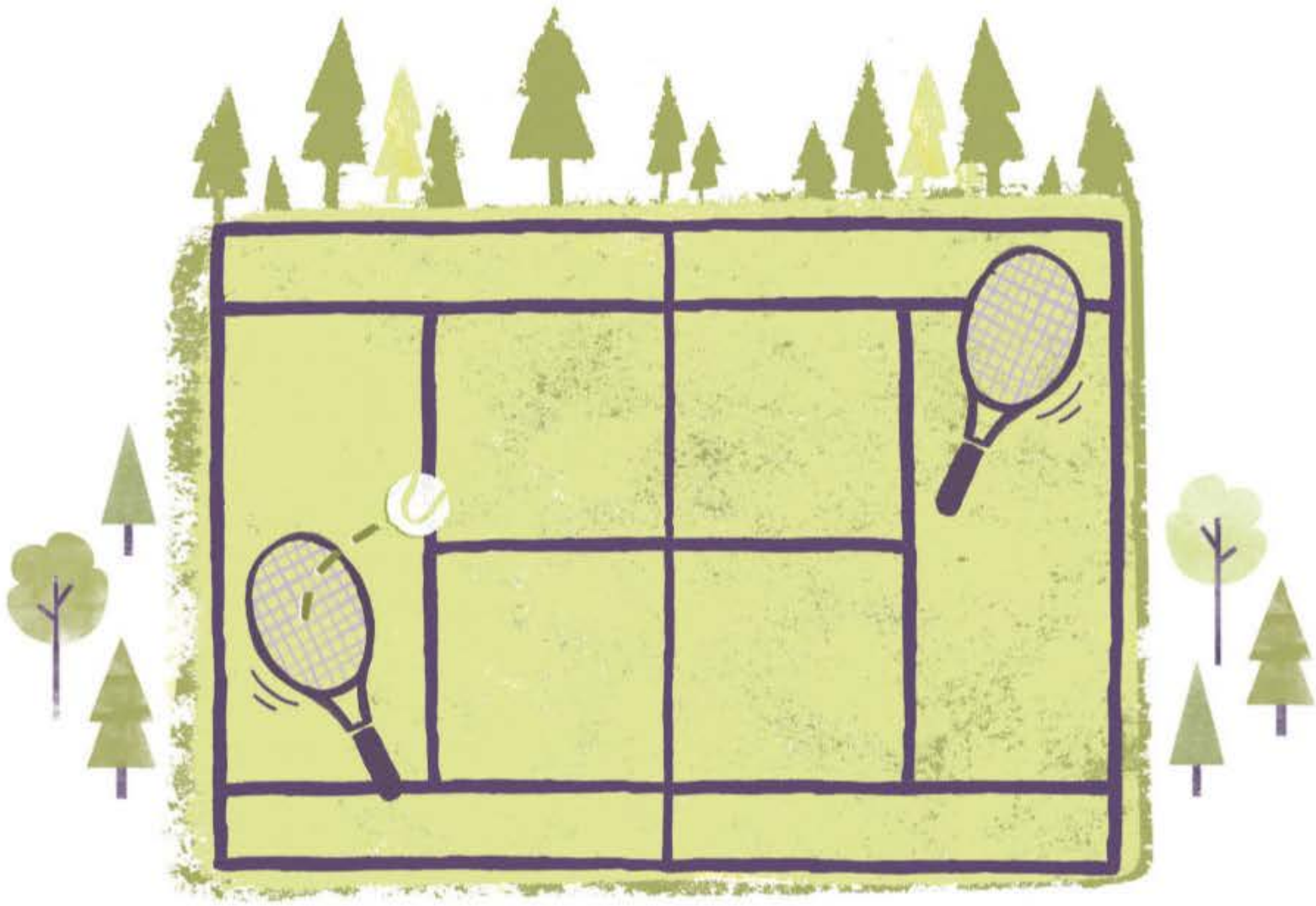

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